MODEL CALIBRATION AND RECEIVING WATER EVALUATION FOR PULP MILL DEVELOPMENTS ON THE ATHABASCA RIVER

Alberta
ENVIRONMENT

MODEL CALIBRATION AND RECEIVING WATER EVALUATION FOR PULP MILL DEVELOPMENTS ON THE ATHABASCA RIVER

I. DISSOLVED OXYGEN

FOR

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BY

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EXECUTIVE SUMMARY

Factors which determine the oxygen content of the Athabasca River include:

- organic loadings, commonly referred to as Biochemical Oxygen Demand (BOD), contributed from effluents and tributaries
- the rate at which the organic material (BOD) oxidizes and removes oxygen from the water
- oxygen consumption exerted by the biological community which develops on the river bottom, i.e. plants, animals and bacteria (often referred to as sediment oxygen demand)
- oxygen content of the river headwater and tributary inflows
- rate at which oxygen is re-introduced to the river from the atmosphere (reaeration).

Assimilative capacity is the river's potential to receive expanded organic loadings and still maintain river oxygen levels above the desired water quality objective. In the case of the Athabasca River the limiting time interval for assimilative capacity is the low flow, ice cover period (January, February and March).

The significant processes controlling Athabasca River oxygen levels have been quantified in a computer simulation model (DOSTOC). Accuracy of the model predictions are a direct function of river specific data for the five factors described above.

Oxygen simulation of the Athabasca River was initiated in the spring of 1988, using field data collected during the winters of 1987 and 1988. Since the dataset was limited, computer model implementation required professional interpretation with respect to:

- river processing rates for the pulp mill organic loadings, especially for Chemithermomechanical Mills (CTMP)
- under ice river reaeration rates
- rates of sediment oxygen demand
- river travel times

Alberta Environment expanded the Athabasca River water quality database during the winter of 1989, and focussed on collecting information to clarify these items. At the same time start-up (Summer 1988) of the Millar Western CTMP mill at Whitecourt provided a second major source of BOD loading to the river, against which the computer model could be tested and confirmed. The other substantial source of organic loading is the Weldwood Kraft mill at Hinton.

This report documents the re-calibration of the Athabasca River oxygen model, and projects water quality conditions with pulp mill expansion. The simulation model was successfully calibrated to five calibration intervals. The difference between the previous calibration and the new calibration is a shift in emphasis from water column BOD oxidation to sediment oxygen demand as the primary oxygen consuming process. The re-calibrated model projects a reduced assimilation rate for the Athabasca River, relative to projections made last year with the limited database. This is because field studies confirmed that winter constituent travel-

times were greater than first anticipated, the SOD is more extensive and the under-ice reaeration rate lower.

The proposed future development of pulp mills along the Athabasca River includes two kraft mills at Hinton (existing) and Town of Athabasca, plus three CTMP mills located at Whitecourt (one existing and a second proposed) and Slave Lake. The re-calibrated computer model indicates that in the case of oxygen, the proposed pulp mill capacity expansion along the upper Athabasca River (upstream of Athabasca Town) can be facilitated as long as BOD_5 effluent standards remain at or below 3.0 kg/Adt. An effluent standard of 3.0 kg/Adt for the Alberta Pacific mill will not permit a similar level of protection for the lower river.

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1.0 INTRODUCTION

Dissolved oxygen modelling for the Athabasca River began in 1987 with very limited historic oxygen and biochemical oxygen demand information. However, sufficient data were available to determine that the most severe river oxygen conditions were created under low-flow ice-covered winter river conditions. These severe dissolved oxygen levels can be attributed to the combination of poor dilution with low flows and a complete ice-cover which almost totally prevents oxygen recharge from the atmosphere.

A river monitoring program was designed and implemented by Alberta Environment in the winter of 1988. It consisted of two complete surveys between Hinton and the Town of Athabasca collecting water samples at regular intervals along the Athabasca River and from major tributaries. At that time the only pulp mill discharging to the Athabasca River was Weldwood (then Champion Forest Products) at Hinton.

Following the monitoring program the water quality model DOSTOC was calibrated to the observed river conditions and then used to predict the effect of proposed future pulp mill effluent loadings. Although the monitoring program provided a good description of the existing river water quality, it did not quantify the process rates i.e., atmospheric reaeration, sediment oxygen demand (SOD) and the oxidation of organic materials (BOD) received from pulp mill effluents.

In calibrating the model, assumptions were made regarding these rates and the relative importance of each of the processes. The modelling approach was a consensus reached between an expert advisor (Linfield Brown, Tufts University), consultants representing Millar Western (IEC BEAK) and consultants retained by Alberta Environment (HydroQual). BOD oxidation was determined to be the dominant oxygen demanding process and was modelled as two

components, one rapid and one slow (Hamilton et al., 1988).

Estimation of river process rates were derived during the winter 1989 Alberta Environment river monitoring program. In addition, the Millar Western pulp mill came on-line at Whitecourt, providing a second major oxygen demand which could be included in the modelling procedure. Utilizing both the 1988 and 1989 monitoring data, measured process rate information and the expert advice of Dr. Linfield Brown, the water quality model DOSTOC has been re-calibrated and used to evaluate future pulp mill BOD loading scenarios.

This report describes in detail the updated Athabasca River oxygen model calibration, procedures for evaluating future BOD effluent loading scenarios, and results of a few select scenario evaluations. The appendices include the complete model input files (hardcopy and diskette) and graphical model output.

2.0 GENERAL MODELLING APPROACH

Model process rates previously set using professional judgement are now defined using actual field measurements of; under-ice time-of-travel (Hinton to Athabasca Town), ice-covered atmospheric reaeration and sediment oxygen demand rates and BOD kinetics. Considering this information, the model has been re-calibrated and the emphasis shifted from the primary oxygen demand being water column BOD oxidation, to sediment oxygen demand (SOD).

The SOD, presumably caused by organic materials (BOD) discharged by the pulp mills, is transferred from the water column to the sediments via adsorption and/or settling. This settled material was visible in 1989 even below the new discharge from Millar Western. It is likely that the organic materials accumulate on the river bottom in a zone immediately below a discharge as the river hydrograph stabilizes toward late November reaching a maximum prior to spring break-up. The high spring river flows probably resuspend the material and transport it through the river system.

Linked to the modelling emphasis on SOD is the rate at which BOD is removed from the water column. This is now the sum of two rates. Firstly, the settling of BOD which is a non-oxygen consuming process and secondly, the oxidation of BOD.

Initial evaluations of the long-term BOD data do not support the hypothesis of a two-component oxidation model for pulp mill effluent and consequently a one-component model has been used. It has, however, been assumed that effluent and background or tributary BOD do oxidize at different rates and they have been modelled as such.

These are the main differences in the modelling approach from 1988 to 1989. Specific rates and changes from 1988 are documented in Sections 3.0 and 4.0.

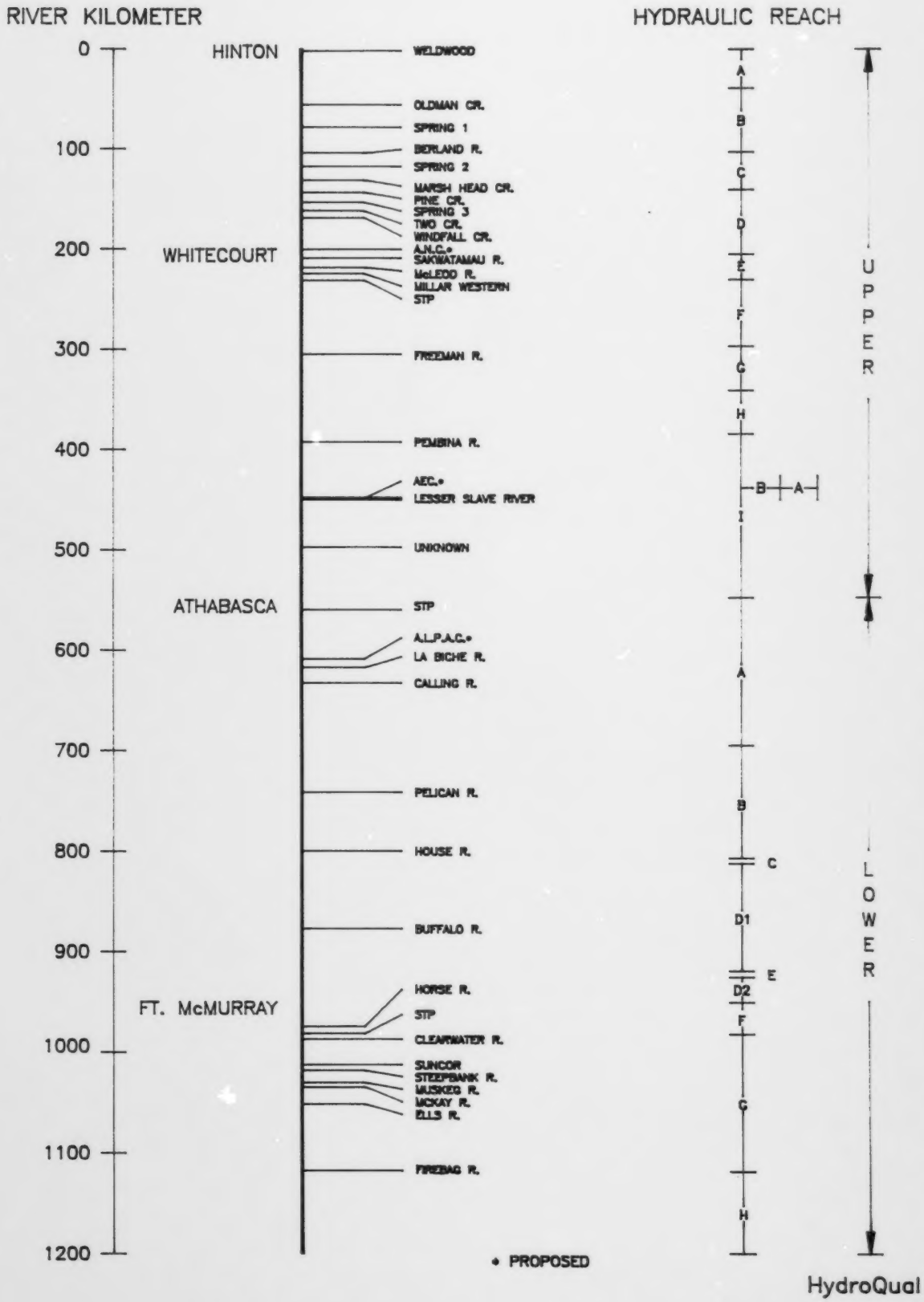
3.0 PHYSICAL MODEL STRUCTURE AND HYDRAULICS

Twelve hundred kilometers of river including 27 tributaries, three sewage treatment plant effluents, one mine discharge (Suncor), two existing pulp mill discharges and three proposed mill discharges were included in the modelled system (Figure 3.1). With the exception of the Lesser Slave River all tributaries and effluent discharges were modelled as point source loads. The Lesser Slave River was also included as a modelled tributary, so that oxygen, BOD and related processes were simulated for 54 kilometers before joining the Athabasca River. This was necessary in order to evaluate the proposed A.E.C. mill discharge to the Lesser Slave River.

The water quality modelling of the Athabasca River required the derivation of representative hydraulic parameters for river reaches between Hinton and Embarras, including the Lesser Slave River. The hydraulic parameters required for the water quality model are reach-average velocity or its inverse, reach travel time, and average depth of flow.

Hydraulic parameters for water quality modelling of the Athabasca River were previously estimated (Hamilton et al., 1988; Macdonald et al., 1989a) on the basis of scant geometric and measured hydraulic data. This was particularly true in the Hinton to Athabasca reach, where cross-section data were scarce and travel time data was non-existent. Between Athabasca and Fort McMurray, the Methyoxychlor Study (Haufe and Croome, 1980) provided cross-section and travel-time data, but the former were not available in time to be included in the earlier study. Data for estimation of hydraulic parameters between Fort McMurray and Embarras were deemed adequate and the parameters now used in the water quality model re-calibration are unchanged from the earlier studies.

FIGURE 3.1 WATER QUALITY MODELLING SCHEMATIC



During fall and winter 1988-1989, under-ice time-of-travel and river cross-sections were measured by Alberta Research Council (Trevor et al., 1988) for the Athabasca River from Hinton to Athabasca and by Radermacher and Thompson (1989) for the Lesser Slave River. These data were used to redefine the hydraulic parameters.

The hydraulic parameters were required for both open-water and ice-covered conditions. Where travel time data were available for an ice-covered condition, such as between Hinton and Athabasca, the ice module option of HEC-2 was used for calibration. Where only open-water travel time data existed, the HEC-2 model was calibrated based on these values and used with the ice-cover option to produce values for the ice-covered condition.

Derivation of the Leopold-Maddock relationships requires values of the pertinent hydraulic parameters as simulated by HEC-2 at each cross-section for a range of flows in both open water and ice-covered conditions. The ice-covered values were produced by HEC-2 using the ice-cover option with an ice underside roughness of 0.026. This option calculates the hydraulic parameters for a fully covered section, with a composite roughness for the channel bed and ice cover. The range of flow values was chosen to ensure that they included the ice-covered and open-water 7Q10 flows for the respective river reach, and the flows at which the water quality models were likely to be calibrated. Sufficient flow values, generally six, were used to provide a good basis for the Leopold-Maddock relationships produced by linear regression of the logarithms of mean depth, velocity and top-width versus flow for both open-water and ice-covered conditions. The reach specific coefficients which were used for all modelling are listed in Tables 3.1 through 3.6 along with the mean depth, top width and velocity calculated using the regression relationships at 50 m^3/s.

A more complete description of the estimation of the hydraulic parameters is in Thompson and Fitch (1989).

Table 3.1. Open-Water Leopold-Maddock Coefficients
Hinton to Athabasca

	Velocity $V=aQ^b$			Average Depth $D=cQ^d$			Top Width $TW=eQ^f$		
Reach	a	b	m/s @ 50 m^3/s	c	d	m @ 50 m^3/s	e	f	m @ 50 m^3/s
A	0.160	0.369	0.678	0.098	0.498	0.688	63.6	0.133	107.
B	0.227	0.336	0.845	0.099	0.499	0.697	44.7	0.165	85.
C	0.292	0.276	0.860	0.136	0.422	0.709	25.2	0.302	82.
D	0.229	0.313	0.779	0.124	0.439	0.691	35.4	0.249	94.
E	0.201	0.362	0.828	0.083	0.463	0.508	60.0	0.175	119.
F	0.267	0.248	0.704	0.144	0.413	0.724	26.0	0.339	98.
G	0.244	0.276	0.718	0.147	0.4387	0.818	27.9	0.286	85.
H	0.122	0.330	0.444	0.125	0.465	0.771	66.0	0.205	147.
I	0.196	0.270	0.564	0.143	0.419	0.737	35.5	0.311	120.

Table 3.2. Ice-Cover Leopold-Maddock Coefficients
Hinton to Athabasca

	Velocity $V=aQ^b$			Average Depth $D=cQ^d$			Top Width $TW=eQ^f$		
Reach	a	b	m/s @ 50 m^3/s	c	d	m @ 50 m^3/s	e	f	m @ 50 m^3/s
A1*	0.131	0.344	0.503	0.115	0.512	0.852	66.3	0.143	116.
A2**	0.110	0.353	0.438	0.126	0.516	0.949	72.0	0.131	120.
B	0.124	0.346	0.480	0.116	0.551	0.997	69.8	0.104	105.
C	0.183	0.266	0.518	0.094	0.540	0.777	57.8	0.194	124.
D	0.147	0.326	0.526	0.083	0.551	0.716	81.5	0.123	132.
E	0.143	0.362	0.589	0.106	0.463	0.649	65.9	0.175	131.
F	0.143	0.274	0.418	0.107	0.536	0.871	65.3	0.189	137.
G	0.0932	0.288	0.288	0.163	0.523	1.261	66.0	0.189	138.
H	0.0653	0.350	0.257	0.125	0.512	0.926	122.4	0.139	211.
I	0.104	0.260	0.288	0.127	0.512	0.941	75.2	0.229	184.

where

V	=	velocity (m/s)
D	=	average depth (m)
TW	=	top width (m)
Q	=	discharge (m^3/s)

* Open water lead (12.2 km) - below effluent
** Remainder of Reach A

Table 3.3. Open-Water Leopold-Maddock Coefficients
Athabasca To Embarras

Reach	Velocity $V=aQ^b$ a	b	m/s @ 50 m^3/s	Average Depth $D=cQ^d$ c	d	m @ 50 m^3/s	Top Width $TW=eQ^f$ e	f	m @ 50 m^3/s
A	0.0869	0.378	0.381	0.0878	0.526	0.687	131	0.0962	191.
B	0.121	0.343	0.463	0.0558	0.551	0.482	147	0.105	222.
C	0.362	0.292	1.135	0.0500	0.505	0.361	55.0	0.203	122.
D1	0.128	0.379	0.564	0.0370	0.575	0.351	210	0.0457	251.
E	0.325	0.294	1.027	0.0160	0.632	0.190	192	0.0741	257.
D2	0.150	0.311	0.506	0.0531	0.475	0.340	125	0.214	289.
F	0.107	0.361	0.439	0.0398	0.566	0.364	234	0.0736	312.
G	0.158	0.250	0.420	0.0996	0.449	0.577	63.5	0.302	207.
H	0.124	0.268	0.354	0.153	0.419	0.788	52.6	0.313	179.

Table 3.4. Ice-Cover Leopold-Maddock Coefficients
Athabasca to Embarras

Reach	Velocity $V=aQ^b$ a	b	m/s @ 50 m^3/s	Average Depth $D=cQ^d$ c	d	m @ 50 m^3/s	Top Width $TW=eQ^f$ e	f	m @ 50 m^3/s
A	0.0963	0.295	0.305	0.0778	0.592	0.788	133	0.113	207.
B	0.0969	0.335	0.359	0.0548	0.598	0.569	188	0.0666	244.
D1	0.0882	0.358	0.358	0.0418	0.627	0.486	271	0.0155	288.
D2	0.114	0.257	0.312	0.0407	0.555	0.357	216	0.188	451.
F	0.151	0.252	0.405	0.0245	0.687	0.360	270	0.0603	342.
G	0.208	0.136	0.354	0.0622	0.542	0.518	77.3	0.321	271.
H	0.0871	0.254	0.235	0.228	0.354	0.911	50.3	0.392	233.

where
- V = velocity (m/s)
- D = average depth (m)
- TW = top width (m)
- Q = discharge (m^3/s)

Table 3.5. Open-Water Leopold-Maddock Coefficients
Lesser Slave River

	Velocity $V=aQ^b$			Average Depth $D=cQ^d$			Top Width $TW=eQ^f$		
Reach	a	b	m/s @ 50 m^3/s	c	d	m @ 50 m^3/s	e	f	m @ 50 m^3/s
A	0.152	0.356	0.612	0.315	0.470	1.981	20.9	0.174	41.
B	0.175	0.287	0.538	0.264	0.434	1.442	21.6	0.280	65.

Table 3.6. Ice-Cover Leopold-Maddock Coefficients
Lesser Slave River

	Velocity $V=aQ^b$			Average Depth $D=cQ^d$			Top Width $TW=eQ^f$		
Reach	a	b	m/s @ 50 m^3/s	c	d	m @ 50 m^3/s	e	f	m @ 50 m^3/s
A	0.130	0.351	0.513	0.245	0.555	2.148	31.4	0.0938	45.
B	0.157	0.289	0.486	0.175	0.536	1.425	36.4	0.175	72.

where
V = velocity (m/s)
D = average depth (m)
TW = top width (m)
Q = discharge (m^3/s)

4.0 MODEL CALIBRATION AND SCENARIO EVALUATIONS

During the winters of 1988 and 1989 five water quality surveys were conducted by Alberta Environment on the Athabasca River and its major tributaries. Samples were collected along the system according to approximate times of travel of the water. The surveys were:

February 1988	-	Hinton to Town of Athabasca
March 1988	-	Hinton to Town of Athabasca
January 1989	-	Survey #1 Hinton to Lake Athabasca
February 1989	-	Survey #2 Whitecourt to Town of Athabasca
February 1989	-	Survey #3 Hinton to Lake Athabasca

These surveys included measurements of dissolved oxygen, biochemical oxygen demand (BOD), and a host of other water quality parameters.

Other information collected in support of water quality modelling were conducted during the winters of 1988 and 1989 and include:

- long term BOD measurements on effluent and river water
- in situ sediment oxygen demand studies
- dye-tracer time-of-travel studies, and river cross-section measurements, for the Athabasca River between Hinton and Town of Athabasca and for the Lesser Slave River
- atmospheric reaeration measurements using the modified tracer gas technique under ice-cover conditions
- winter aerial photography of the Athabasca River from Hinton to the Pembina River confluence

- mainstem and tributary discharge measurements

The water quality model DOSTOC (HydroQual and Gore & Storrie Ltd, 1987) was used to simulate dissolved oxygen and biochemical oxygen demand. The model was calibrated to conditions observed on each of the five surveys incorporating all of the previous mentioned information. The calibrated model was then used to evaluate the effect of future pulp mill development on Athabasca River dissolved oxygen levels.

The following is a description of rates and assumptions used in both the model calibration and pulp mill development scenario evaluations.

4.1 Hydrology

Winter flows in the Athabasca River increase substantially with distance down the basin. In 1989 Survey #3 the upstream flow (Hinton) was 31.3 m^3/s and 130.0 m^3/s near the bottom of the basin (Embarras). For water quality modelling all of the inflow which causes the increase in river flow must be assigned to specific locations. To facilitate this discharge measurements were made for all of the major tributaries which flow into the Athabasca River. Smaller ungauged inflows do contribute to the Athabasca River flows and to determine the amounts of these smaller inflows and the river reaches where they are received, mainstem river discharge measurements were made at specific locations along the river. In this way a flow balance could be achieved for each reach by calculating the difference between the sum of the upstream river discharge and measured tributary inflows, and the downstream river discharge. The difference, which can be either ungauged inflows or measurement imprecision (discharge measurements in large rivers with under-ice conditions is very difficult to do with precision) are assigned to inflow locations. In the river reach between

Hinton and Whitecourt ungauged inflows consistently occur. The following sections describe how these discrepancies in measured flows are handled in the calibrations and scenario evaluations.

4.1.1 Calibration

Detailed discharge measurements were made during all water quality sampling surveys and were the results used to define flows for model calibration. When a measured mainstem discharge was greater than the sum of upstream inflows, the difference was attributed to an artificial inflow or withdrawal.

1988 February/March Surveys

Major tributaries and five mainstem Athabasca River locations were monitored for discharge during these surveys.

Discrepancies in the flow balance were resolved by assigning missing flows to known but ungauged tributaries or to known spring locations. Overall a total of 15.4 m^3/s and 9.7 m^3/s were assigned to these locations in the February and March 1988 Surveys respectively. This represents 23.5 and 16.6 per cent of the measured flow at the Town of Athabasca.

1989 Surveys #1-3

Discharge measurements were more extensive in the 1989 Surveys to include more tributaries and eight mainstem Athabasca locations between Hinton and Embarras. In Survey #1 a total of 22.2 m^3/s or 14.1 per cent of the flow at Embarras, was unaccounted for and added to upstream springs or tributaries. Only 5.7 m^3/s or 4.3 per cent of the flow at Embarras was calculated to be missing for Survey #3. This is due to a flow surplus between Windfall and Smith and a flow deficit between upstream Berland and Windfall. Survey #2, which only included Whitecourt to the Town of Athabasca,

required the addition of 6.7 m^3/s or 8.0 per cent of the flow at Athabasca to balance.

4.1.2 Scenario Evaluations

In order to evaluate future development scenario effects on water quality synthetic low-flow conditions were modelled. These were calculated by Bothe and Siemonsen (1989) and reflect the seven day average flows which would occur one in ten years (7Q10) at four locations in the basin. As well as calculating the 7Q10 flow at each of the four locations, they also determined what the likely flows would be elsewhere in the basin (including tributaries) when the particular 7Q10 flow occurred. These are listed in Table 4.1.1.

In Table 4.1.1 local inflows are defined for a reach of river (e.g. Athabasca to House Local). For modelling, local inflows were assigned to an inflow location, and wherever possible these were assigned to adjacent tributaries with measured water quality. When this was not possible a new inflow was created approximately half-way along the local inflow reach.

4.2 Open-Water Zones

4.2.1 Calibration

With only a few exceptions, the Athabasca River was completely ice-covered in 1989. In the less severe winter of 1988, a few more open-water leads were identified. Below mill discharges significant open-water zones are created by thermal effluent. The length of the zone affects the amount of oxygen exchange which can take place with the atmosphere. The open-water zone lengths which have been used during model calibration are:

Table 4.1.1 Athabasca River Basin Annual 7Q10 Flows (m^3/s) (Source: Bothe & Siemonsen (1989)).

	Point of Interest							
	Hinton		Whitecourt		Athabasca		Fort McMurray	
	Local	Total	Local	Total	Local	Total	Local	Total
Athabasca at Hinton		15.8		25.1		27.1		31.4
Hinton to Berland Local	5.2	21.0	0.7	25.8	2.3	29.4	2.4	33.8
Berland River	12.0	33.0	1.7	27.5	5.2	34.6	5.6	39.4
Sakwatamau River	2.9	35.9	0.4	27.9	1.3	35.9	1.4	40.8
Berland to Windfall Local	11.3	47.2	1.6	29.5	5.0	40.9	5.3	46.1
Athabasca near Windfall		47.2		29.5		40.9		46.1
McLeod at Whitecourt	5.0	52.2	3.8	33.3	2.3	43.2	8.2	54.3
Athabasca at Whitecourt		52.2		33.3		43.2		54.3
McLeod to Freeman Local	0.4	52.6	1.4	34.7	0.1	43.3	0.1	54.4
Freeman River	0.4	53.0	1.2	35.9	0.1	43.4	0.1	54.5
Freeman to Pembina Local	0.7	53.7	2.3	38.2	0.2	43.6	0.2	54.7
Pembina River	3.1	56.8	5.5	43.7	1.8	45.4	2.0	56.7
Pembina to Lesser Slave Local	1.6	58.4	5.0	48.7	0.3	45.7	0.5	57.2
Lesser Slave River	15.6	74.0	31.3	80.0	7.5	53.2	8.9	66.1
Lesser Slave to Athabasca Local	0.6	74.6	2.0	82.0	0.1	53.3	0.2	66.3
Athabasca at Athabasca		74.6		82.0		53.3		66.3
Athabasca to House Local	19.3	93.9	34.1	116.1	7.5	60.8	5.0	71.3
House River	0.8	94.7	1.4	117.5	0.3	61.1	0.2	71.5
House to Fort McMurray Local	7.5	102.2	13.2	130.7	2.9	64.0	1.9	73.4
Clearwater River	61.0	163.2	76.5	207.2	44.9	108.9	40.6	114.0
Athabasca below McMurray		163.2		207.2		108.9		114.0
Athabasca below McMurray to Poplar Local	0.1	163.3	0.1	207.3	0.1	109.0	0.1	114.1
Poplar Creek	0.0	163.3	0.0	207.3	0.1	109.1	0.1	114.2
Poplar to Steepbank Local	0.1	163.4	0.1	207.4	0.1	109.2	0.1	114.3
Steepbank River	0.4	163.8	0.4	207.8	0.5	109.7	0.5	114.8
Steepbank to Muskeg Local	0.2	164.0	0.2	208.0	0.3	110.0	0.3	115.1
Muskeg River	0.3	164.3	0.3	208.3	0.4	110.4	0.4	115.5
Muskeg to MacKay Local	0.0	164.3	0.0	208.3	0.0	110.4	0.0	115.5
MacKay River	0.5	164.8	0.5	208.8	0.5	110.9	0.4	115.9
MacKay to Ells Local	0.0	164.8	0.0	208.8	0.1	111.0	0.0	115.9
Ells River	1.0	165.8	1.0	209.8	1.5	112.5	1.4	117.3
Ells to Firebag Local	0.7	166.5	0.7	210.5	1.0	113.5	0.9	118.2
Firebag River	9.1	175.6	9.1	219.6	6.6	120.1	6.2	124.4
Firebag to Embarras Airport Local	0.5	176.1	0.5	220.1	0.7	120.8	0.7	125.1
Athabasca at Embarras Airport		176.1		220.1		120.8		125.1

	d/s Weldwood (km)	d/s Millar Western (km)
February 1988	8.5	-
March 1988	22.5	-
Survey #1 1989	8.5	1.5
Survey #2 1989	-	1.5
Survey #3 1989	12.2	1.5

The 1988 lengths were determined by visual mapping from the air at the time of the water quality survey. Aerial photographs taken on February 17, 1989 were interpreted to determine open-water zones for all three 1989 surveys, with the exception of downstream Weldwood during Survey #1 which was defined from observations at the time of the survey.

4.2.2 Scenario Evaluations

In the scenario evaluations, mill size, mill process type, weather conditions and receiving water discharge are all factors considered in determining open-water zone lengths below existing and proposed mills. The following open-water zone lengths were used in all scenario evaluations:

	km
Weldwood	12.2
A.N.C.	2.0
Millar Western	1.5
A.E.C.	1.0
ALPAC	1.0

4.3 Biochemical Oxygen Demand (BOD)

When modelling oxygen consumption caused by the oxidation of organic materials, two key parameters must be defined:

1) the total amount of oxygen which would be consumed when all of the organic materials are oxidized - Ultimate BOD (BOD_u)

2) the rate at which the organic materials are oxidized in the river system - BOD oxidation

BOD is conventionally measured as five-day BOD (BOD_5) which is defined as the amount of oxygen consumed in five days. This is converted to BOD_u using a laboratory or literature determined value.

4.3.1 Calibration

Preliminary oxygen modelling of the Athabasca River in 1988 (Hamilton et al., 1988) assumed the organic materials in the Athabasca River were composed of two components, fast and slow, which oxidized at two different rates, 0.2 (day^{-1}, 0^oC) for kraft mills or 0.365 (day^{-1}, 0^oC) for CTMP mills and 0.04 (day^{-1}, 0^oC) respectively. The fast component was assumed to represent 33-40 per cent of mill effluent BOD depending upon the treatment process and the slow component was assumed to include all background BOD (i.e. tributaries and headwaters) and the remaining 60-67% of the mill effluent BOD. The conversion from BOD_5 to BOD_u was assumed to be 2.0 for the fast component and 5.5 for the slow component.

Previous BOD kinetic assumptions were based upon literature and model calibration using river BOD_5 and dissolved oxygen. In 1989 Millar Western and Weldwood effluent samples were monitored for greater than 120 days to determine BOD oxidation rates, the amount of ultimate BOD and consequently a BOD_u/BOD_5 relationship. Rates were determined by fitting a curve to the observed data using an iterative non-linear least-squares regression and a one-component model. Results for K_1 (the BOD oxidation rate) and L_1 (the BOD_u

amount) are listed in Table 4.3.1 for the Weldwood kraft effluent and the Millar Western CTMP effluent. The average K_1 is equal to 0.05 (day^{-1}, 20°C) for Millar Western and 0.035 (day^{-1}, 20°C) for Weldwood, and the average BOD_u/BOD_5 ratios are 5.0 and 4.0 respectively.

Regression results for a one-component model are included in Table 4.3.1. Two-component model regressions were evaluated but to date have not provided consistent results and were therefore, not included. As more of the long-term BOD data results are received, the two-component model will be further evaluated.

In calibrating the model it has been assumed that there are two types of BOD in the Athabasca River:

1) Background river BOD including that derived from headwaters and tributaries BOD

2) Effluent BOD including industrial and municipal effluents

Each type of BOD oxidizes according to the one-component model but has a different rate (K_1) and a different BOD_u/BOD_5 ratio. The rates and ratios which were assumed for calibration are:

	K_1 (day^{-1}, 0°C)	BOD_u/BOD_5
Background BOD	0.02	6.4
Weldwood	0.035	5.0
Millar Western	0.05	4.0
Other Effluent	0.05	2.0

To facilitate two types of BOD in a model designed for one type, i.e. DOSTOC, the background river BOD was simulated as the variable intended for nitrogenous oxygen demand NOD. Both variables are treated as first-order decay functions.

Table 4.3.1 Athabasca River Project - Summary of BOD ultimate analysis for pulpmill wastewaters (Preliminary)

	SAMPLING DATE YR MM DD	% DILUTION	L1	K1	MEASURED* BOD5 mg/L	MEASURED* RATIO BODU/ BOD5	CALCULATED** BOD5 mg/L	CALCULATED** RATIO BODU/ BOD5
MILLAR WESTERN	88 10 24	3	422	0.059	116	3.6	108	3.9
	88 10 24	5	399	0.072	121	3.3	121	3.3
	88 10 24	10	350	0.052	109	3.2	80	4.4
	88 11 16	3	978	0.045	299	3.3	197	5.0
	88 11 16	3	959	0.054	304	3.2	227	4.2
	88 11 16	5	664	0.051	222	3.0	149	4.4
	88 11 16	5	645	0.056	226	2.9	158	4.1
	88 11 16	10	584	0.055	199	2.9	140	4.2
	88 11 16	10	598	0.048	192	3.1	128	4.7
	88 12 9	3	479	0.035	98	4.9	77	6.2
	88 12 9	5	468	0.039	89	5.3	83	5.6
	89 1 12	1	2102	0.078	716	2.9	679	3.1
	89 1 12	1	2265	0.065	714	3.2	628	3.6
	89 1 12	3	2007	0.043	494	4.1	388	5.2
	89 1 12	3	2043	0.043	499	4.1	395	5.2
	89 1 26	1	1708	0.036	325	5.3	281	6.1
	89 1 26	1	1588	0.038	324	4.9	275	5.8
	89 1 26	3	1405	0.042	310	4.5	266	5.3
	89 1 26	3	1324	0.044	318	4.2	261	5.1
	89 2 16	1	2422	0.035	493	4.9	389	6.2
	89 2 16	1	2922	0.029	536	5.5	394	7.4
	89 2 16	3	2712	0.042	580	4.7	514	5.3
	89 2 16	3	2776	0.037	556	5.0	469	5.9
AVG				0.048		4.0		5.0
WELDWOOD	88 12 2	10	222	0.035	49	4.5	36	6.2
	88 12 2	15	253	0.034	55	4.6	40	6.4
	88 12 2	20	233	0.036	52	4.5	38	6.1
	89 1 9	3	141	0.038	40	3.5	24	5.8
AVG				0.036		4.3		6.1

L1 BOD ultimate

K1 BOD oxidation rate (day^{-1}, $0^{o}C$);

* measured at Alberta Environmental Centre, Vegreville;

** as derived from first order equation

4.3.2 Scenario Evaluations

Biochemical oxygen demand oxidation rates (K_1) and BOD_u/BOD_5 ratios used in the scenario evaluations are as follows:

	K_1 (day^{-1}, 0^oC)	BOD_u/BOD_5
Weldwood	0.035	5.0
A.N.C.	0.05	4.0
Millar Western	0.05	4.0
A.E.C.	0.05	4.0
ALPAC	0.035	5.0
Other Effluent	0.035	2.0
Background	0.02	6.4

Rates and ratios were simply categorized as kraft or CTMP and assigned a rate equal to that calculated for Weldwood or Millar Western respectively.

4.4 Headwater, Tributary and Mainstem Water Quality

4.4.1 Calibration

Measured water quality data is used to define the headwater condition (Athabasca River at Hinton and Lesser Slave River at Slave Lake), the tributary and effluent discharge quality, and to define the water quality profile along the length of the mainstem river. In all cases measurements of dissolved oxygen and biochemical oxygen demand are required. Alberta Environment data were used exclusively for this purpose.

For each of the five calibration intervals the actual measured water quality were used. Five day BOD measurements were converted to ultimate BOD using ratios described in Section 4.3.1. Actual

measurement values of oxygen and BOD used in model calibration are listed in the input files included in Appendix 2.1. Table 4.4.1 lists the historic average dissolved oxygen and BOD_5 conditions for the headwater (Athabasca at Hinton) and the modelled tributaries.

Any simulated inflow which did not have a measured quality was assumed to be the same as that measured for Oldman Creek.

The measured river temperature for all surveys and all rive sites was always near 0°C. Consequently this value was used for all calibration intervals.

Appendix 2.2 lists the mainstem river water quality data by river kilometer including a mean minus one standard deviation, mean, and mean plus one standard deviation. They are also plotted on the calibration figures in Section 5 and Appendix 1.0.

4.4.2 Scenario Evaluations

Headwater and tributary quality for the scenario evaluations were assumed to be those observed in Survey #3, 1989. Local inflows were assigned the same quality as measured for Spring #1.

4.5 Atmospheric Reaeration Rate

4.5.1 Calibration

Previous oxygen modelling studies on the Athabasca River assumed an under-ice reaeration rate which was 3-5 per cent (0.08 - 0.20 day^{-1}, 50 m^3/s, 20°C) of the calculated open-water rate and an open-water rate calculated using the O'Connor and Dobbins (1958) reaeration equation (Hamilton et al., 1988). In March 1989 reaeration measurements were made in an open-water zone below Weldwood and in a 50 km ice-covered reach upstream of the Berland River (Macdonald et al., 1989a). Results indicated that the open-

Table 4.4.1 Historic average dissolved oxygen and five-day BOD for the Athabasca at Hinton and major tributaries.

SITE	OXYGEN MG/L			BOD5 MG/L		
	N	AVG	STD DEV	N	AVG	STD DEV
ATHABASCA @ HINTON	72	11.3	0.58	19	0.88	0.63
OLDMAN CR.	5	12.7	0.32	4	1.62	0.92
SPRING 1	2	11.6	0.099	2	1.05	0.07
BERLAND R.	5	10	0.84	5	1.26	0.36
SPRING 2	2	11.9	0.26	2	0.4	0.42
MARSH HEAD CR.	2	11.1	0.84	2	0.75	0.07
PINE CR.	2	11.4	1.1	2	0.4	0.14
SPRING 3	2	11.1	0.47	2	0.4	0.28
TWO CR.	2	9.2	1.8	2	1.22	0.21
WINDFALL CR.	5	11.1	1.24	4	1.1	0.71
MCLEOD R.	31	5.6	1.19	8	1.29	0.71
FREEMAN R.	5	8.3	1.8	5	1.38	0.56
PEMBINA R.	13	2.9	1.55	5	0.95	0.55
LESSER SLAVE R.	19	12	0.33	5	1.18	0.96
LA BICHE R.	2	7.8	0.48	2	0.6	0.28
CALLING R.	2	11.2	0.42	2	0.7	0.14
PELICAN R.	2	12.9	0.11	2	2.35	1.06
HOUSE R.	2	9.8	1.05	2	0.75	0.21
BUFFALO R.	1	8.7		1	0.7	
HORSE R.	2	13.1	0.25	2	0.8	0.57
CLEARWATER R.	2	12.4	0.12	2	0.62	0.39
STEEPBANK R.	2	13.3	0.26	2	1.05	0.35
MUSKEG R.	2	8.4	3.4	2	1.15	0.78
MCKAY R.	2	12.1	0.2	2	1.15	0.5
ELLS R	2	12.7	0.44	2	0.75	0.21
FIREBAG R.	2	5.5	0.37	2	1.28	0.67

water rate was 0.8 day^{-1} and the ice-covered rate was not significantly different from zero; both were measured near 30 m^3/s and 0°C.

For model calibration we have assumed these measured rate for the entire river system. That is to say, the ice-covered rate was set equal to 0.001 day^{-1} and the open-water rate equal to 16 per cent of the calculated open-water rate at 20°C and 50 m^3/s. The percentage was calculated as that which would match the measured open-water rate. All reference rates used in the model are for 0°C and 50 m^3/s.

The only time that the above assumptions were altered was in the 1988 calibrations. Here an ice-covered reaeration rate of 0.03 day^{-1}(0°C, 50 m^3/s) was required to calibrate to the observed oxygen profile. The rationale for this being that 1988 was a much warmer winter than 1989 and the potential for open-water leads, where reaeration could occur, greater.

4.5.2 Scenario Evaluations

An ice-covered reaeration rate of 0.001 day^{-1} and open-water rates equal to 16 per cent of calculated were used in all scenario evaluations.

4.6 Effluent BOD Settling Rate

Organic material in the water column can be removed to the sediments via adsorption or settling. In modelling BOD the process has been lumped into a settling term. This phenomenon has been observed below both Millar Western and Weldwood effluent discharges.

4.6.1 Calibration

The BOD settling rate was determined by simultaneously calibrating to the observed loss of water column BOD and the consumption of oxygen. While settling itself is not an oxygen consuming process, low settling rates mean more water column BOD and consequently a higher oxygen demand. The values used in model calibration for the five calibration intervals are listed in Table 4.6.1. The variable rate below Millar Western between Survey #1 and Survey #3, is likely due to inconsistencies in effluent composition, typical of a new mill.

4.6.2 Scenario Evaluations

For future development evaluations the settling rates below Weldwood and Millar Western are those determined in the 1989 Survey #3 calibration. Below other mills a rate was set which reflected process types; kraft mills similar to Weldwood and CTMP mills similar to Millar Western. The reach specific numbers can be found in Appendix 4.0 in the scenario evaluation input files. The settling rate does not change with changes in BOD loading.

4.7 Sediment Oxygen Demand (SOD)

In the 1988 oxygen modelling (Hamilton et al., 1988) a sediment oxygen demand (SOD) was included below Weldwood but not below new mills. The value was determined during model calibration and ranged from 2.0 to 9.0 mg/L/day at 0°C. Subsequently Alberta Environment measurements of SOD above and below both Millar Western and Weldwood (Casey and Noton, 1989) have indicated values an order of magnitude lower.

4.7.1 Calibration

Using data from Casey and Noton (1989) as a guide, sediment oxygen demands were attributed to reaches downstream of mill discharges. Casey and Noton (1989) measured values as high as 0.44 $g/m^2/day$ below Weldwood and 0.61 $g/m^2/day$ below Millar Western. Values used in model calibration are listed in Table 4.6.1.

While model SOD rates are higher than measured, they are not outside the plausible range and are the values required to provide an oxygen uptake equal to that observed immediately below the mill discharges.

Organic materials which were removed from the water column could be creating a sediment oxygen demand which would gradually increase from the beginning of the low flow period (around December) to a maximum before spring break-up (early April) (Linfield Brown, personal communication). The modelled changes in SOD from Survey #1 to Survey #3 are consistent with this hypothesis.

4.7.2 Scenario Evaluations

SOD is the result of the accumulation of organic material deposited from the water column, and as such, less organic material in the water column means a lower SOD. Although this relationship is not clearly understood, it was assumed for scenario evaluations that SOD was linearly related to pulp mill effluent BOD load. The SOD reach specific distributions used in the 1989 Survey #3 calibration was applied to all scenario evaluations, however the SOD value was scaled up or down depending upon the change in BOD load. For example, in 1989 Survey #3 the BOD_5 load from Weldwood was 1842 kg/day and 5967 kg/day from Millar Western and the corresponding calibration SOD values were 0.65 and 0.85 mg/L/day immediately downstream. In a development scenario with a BOD_5 load from Weldwood of 3300 kg/day the SOD would be 1.16 mg/L/day.

Table 4.6.1 BOD settling rates and sediment oxygen demand rates used in model calibration. (All rates for 0°C and 50 m^3/s).

Reach #	Length (km)	February 1988 K3 (day^{-1})	February 1988 SOD (mg/L/day)	March 1988 K3 (day^{-1})	March 1988 SOD (mg/L/day)	Survey #1 1989 K3 (day^{-1})	Survey #1 1989 SOD (mg/L/day)	Survey #2 1989 K3 (day^{-1})	Survey #2 1989 SOD (mg/L/day)	Survey #3 1989 K3 (day^{-1})	Survey #3 1989 SOD (mg/L/day)
Reaches Below Weldwood											
2	12.2	0.15	0.65	0.15	0.65	0.15	0.65	-	-	0.15	0.65
3	23.6	0.1	0.55	0.1	0.55	0.1	0.25	-	-	0.1	0.55
4	18.6	0.1	0.35	0.1	0.35	0.1	0.0	-	-	0.1	0.35
5	22.5	0.05	0.10	0.05	0.10	0.05	0.0	-	-	0.05	0.10
6	25.8	0.05	0.07	0.05	0.07	0.05	0.0	-	-	0.05	0.07
7	13.3	0.05	0.07	0.05	0.07	0.05	0.0	-	-	0.05	0.07
8	13.8	0.05	0.07	0.05	0.07	0.05	0.0	-	-	0.05	0.07
Reaches Below Millar Western											
19	1.5	-	-	-	-	1.3	0.85	0.9	0.85	0.7	0.85
20	2.1	-	-	-	-	1.3	0.85	0.9	0.85	0.7	0.85
21	21.1	-	-	-	-	1.3	0.85	0.9	0.85	0.7	0.85
22	70.0	-	-	-	-	0.9	0.25	0.6	0.35	0.4	0.55
23	44.6	-	-	-	-	0.6	0.0	0.4	0.0	0.3	0.10
24	31.5	-	-	-	-	0.6	0.0	0.4	0.0	0.3	0.10

K3 - BOD settling rate
SOD - Sediment oxygen demand

Values used for various scenarios are detailed in the input files in Appendix 3.

4.8 Diffuse Dissolved Oxygen Loading

Grand Rapids, which is just downstream of the House River, provides a source of dissolved oxygen to the Athabasca River. The turbulent water and reduced ice-cover enables a rapid oxygen exchange between the water and the atmosphere. Continuous oxygen monitoring upstream and downstream of the rapids indicates the average oxygen increase to be 4.7 mg/L.

4.8.1 Calibration

To account for this rapid increase in dissolved oxygen at Grand Rapids a diffuse dissolved oxygen loading was used. The load was calculated to equal a 4.7 mg/L increase in river oxygen. The option of simply setting a high reaeration rate for that reach was excluded because the effect of a high reaeration rate is dependent upon river hydraulics and river oxygen levels. To simulate the change in oxygen in this way would require specific knowledge of the relationships between upstream river oxygen, hydraulics, and reaeration in Grand Rapids.

The amount of the diffuse load for the only two calibrations which included this reach of river (1989 Survey #1 and Survey #3) were 4760.3 and 3461.2 tonnes/km/day respectively. Differences are due to different river discharges.

4.8.2 Scenario Evaluations

Two river discharge scenarios other than the 1989 Survey #3 observed which were used in the scenario evaluation are the Whitecourt 7Q10 and Athabasca 7Q10. The diffuse oxygen load for

these scenarios are 6064.27 and 2602.57 tonnes/km/day respectively.

4.9 Saturation of Dissolved Oxygen

The saturation of oxygen for the Athabasca River at 0°C was calculated using an average station pressure of 93.02 kPa (Whitecourt Meteorologic Station) and a saturation at sea level of 14.16 mg/L (Wetzel, 1975). This is equal to a value of 13.0 mg/L which was used for all simulations.

5.0 MODEL CALIBRATION RESULTS

Three model calibration results were selected to demonstrate the observed and predicted conditions in 1988, prior to Millar Western coming on-line, compared with 1989, and to describe the calibration for the entire river from Hinton to Embarras. A complete set of calibration results for both dissolved oxygen and BOD_5 for all five calibration intervals are included in Appendix 1.

Figure 5.1 shows the observed mainstem dissolved oxygen data (as a mean, plus and minus one standard deviation), the simulation oxygen results (continuous line), and the Alberta surface water quality objective of 5.0 mg/L for the 557 kilometers from Hinton (kilometer 0) to the Town of Athabasca during March 1988. At Hinton the oxygen level is 1.5 mg/L below saturation, at approximately 11.5 mg/L. Within the first eighty kilometers the oxygen declines to 10.0 mg/L from the SOD and BOD oxidation. By this point the Weldwood effluent BOD is almost completely oxidized or removed to the sediments, however, the dissolved oxygen levels continue to decline at a constant slow rate, due to background BOD oxidation, to a minimum value of 9.0 mg/L at Athabasca. The simulated oxygen levels approximate the observed values except in the area immediately below the Weldwood discharge where the simulated is greater than the observed. This is coincident with a large open-water zone (22.5 km) indicating that the open-water reaeration rate may be high.

With the Millar Western mill on-line, an oxygen sag of 2.5 mg/L between Whitecourt (km 210) and the Lesser Slave River (km 450) was observed and simulated for 1989 Survey #1 (Figure 5.2). The oxygen recovers to 9.0 mg/L with the addition of oxygenated Lesser Slave River water but immediately begins to decrease, reaching a minimum of 7.5 mg/L upstream of Grand Rapids. Considerable reaeration takes place in the rapids returning the river to near saturation values, after which the gradual oxygen depletion continues until

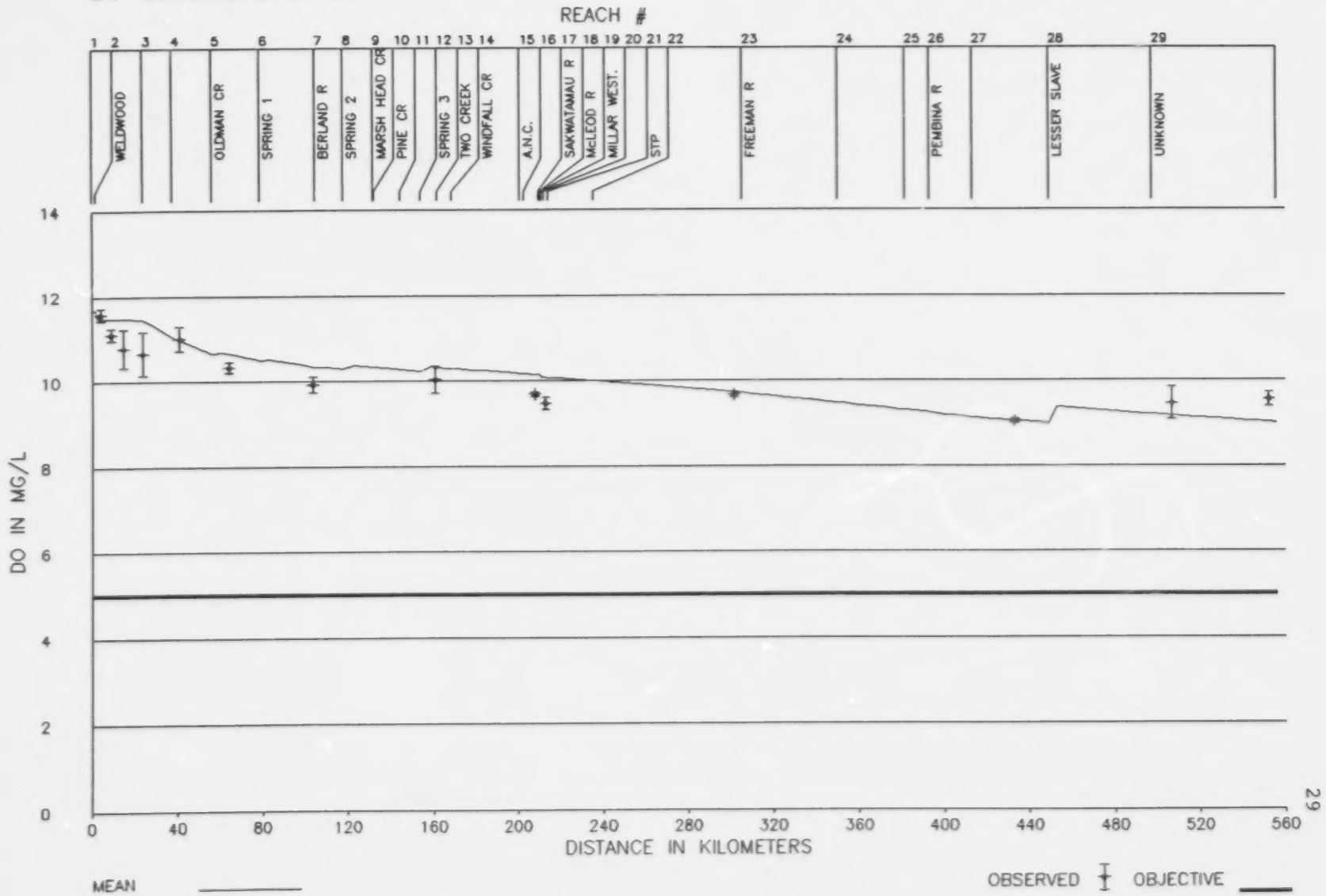
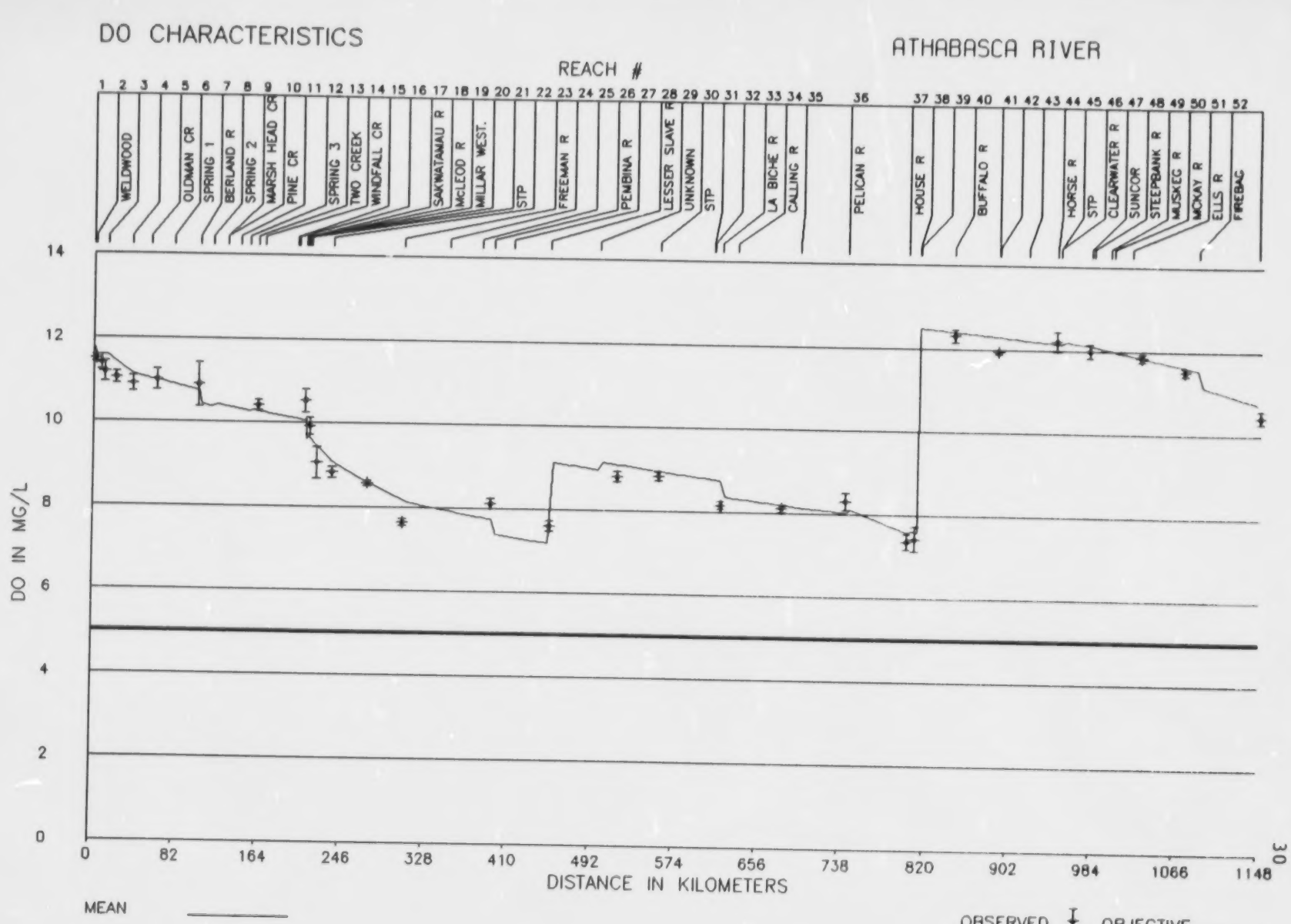


Figure 5.1
HydroQual

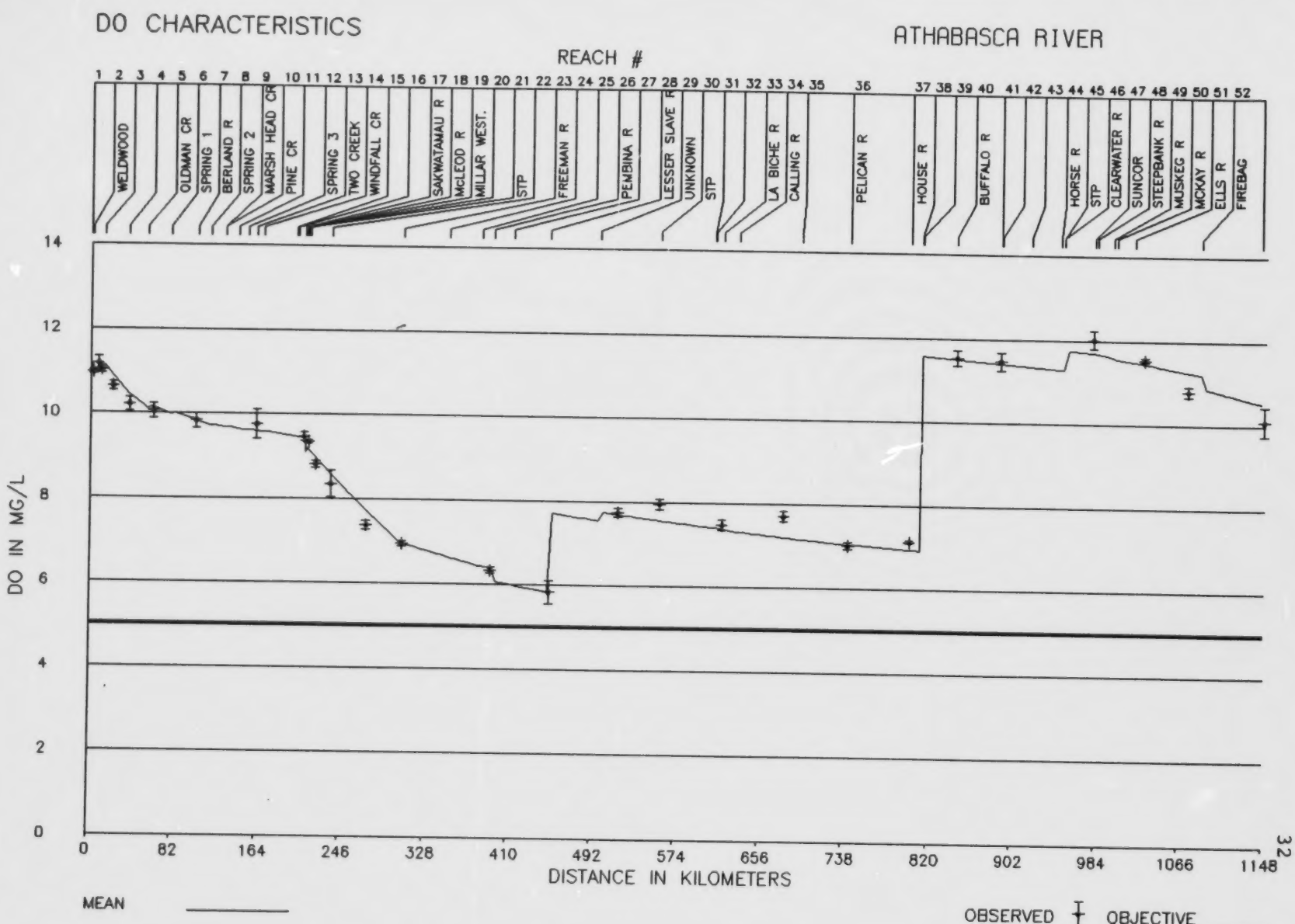


SURVEY #1 1989 [89.06.13]

Figure 5.2
HydroQual

the simulation ends at Embarras. The oxygen simulation results closely match the observed values, indicating a good calibration.

In Survey #3, which was completed in March 1989, a similar oxygen profile to Survey #1 was observed and simulated (Figure 5.3). However, oxygen depletion below both Weldwood and Millar Western was greater in Survey #3. This supports the theory that SOD accumulates over time. A minimum oxygen just below 6.0 mg/L occurred upstream of the Lesser Slave River. The model produced simulated oxygen results which accurately describe the observed oxygen profile.



SURVEY #3 1989 [89.06.13]

Figure 5.3
HydroQual

6.0 SCENARIO EVALUATION RESULTS

Future pulp mill effluent BOD loadings were evaluated for three flow conditions:

1) 1989 Survey #3 Observed Flows
2) 7Q10 Whitecourt Flows
3) 7Q10 Athabasca Flows

These flows are compared in Figure 6.1. Upstream of the Lesser Slave River (km 0 to 410) the Whitecourt 7Q10 flows are the lowest (30-40 m^3/s) followed closely by the Athabasca 7Q10 and then the 1989 Observed Flows. Below the Lesser Slave River the Athabasca 7Q10 flows become the most restrictive. The least restrictive flows were the Whitecourt 7Q10. The 1989 flows average only 10 to 15 m^3/s more than the Athabasca 7Q10. From the Town of Athabasca (km 556) to Fort McMurray (km 9850) there are considerable inflows in the synthetic 7Q10 flows but not in the observed flows, this becomes a factor in the evaluations as this is the reach of river used for assimilating the ALPAC discharge.

For each of the three flow conditions, six effluent loading scenarios were modelled. A description of each loading scenario is listed in Table 6.1. Case #1 is the load used in the March 1988 calibration and includes only Weldwood making a total BOD_5 loading of 2,949 kg/day. The 1989 Survey #3 BOD loads were used in Case #2. Case #3 is the current maximum permitted BOD discharge from Weldwood and Millar Western totalling 11,710 kg/day. In Case #4 the Weldwood expansion is considered with an effluent standard of 7.0 kg/Adt as well as the inclusion of A.N.C. and A.E.C. Cases #5 and #6 assume full pulp mill development scenarios where each mill has the same effluent standard.

Figures 6.2 through 6.4 compare the six different loading scenarios for each of the three flow conditions. The Weldwood discharge is

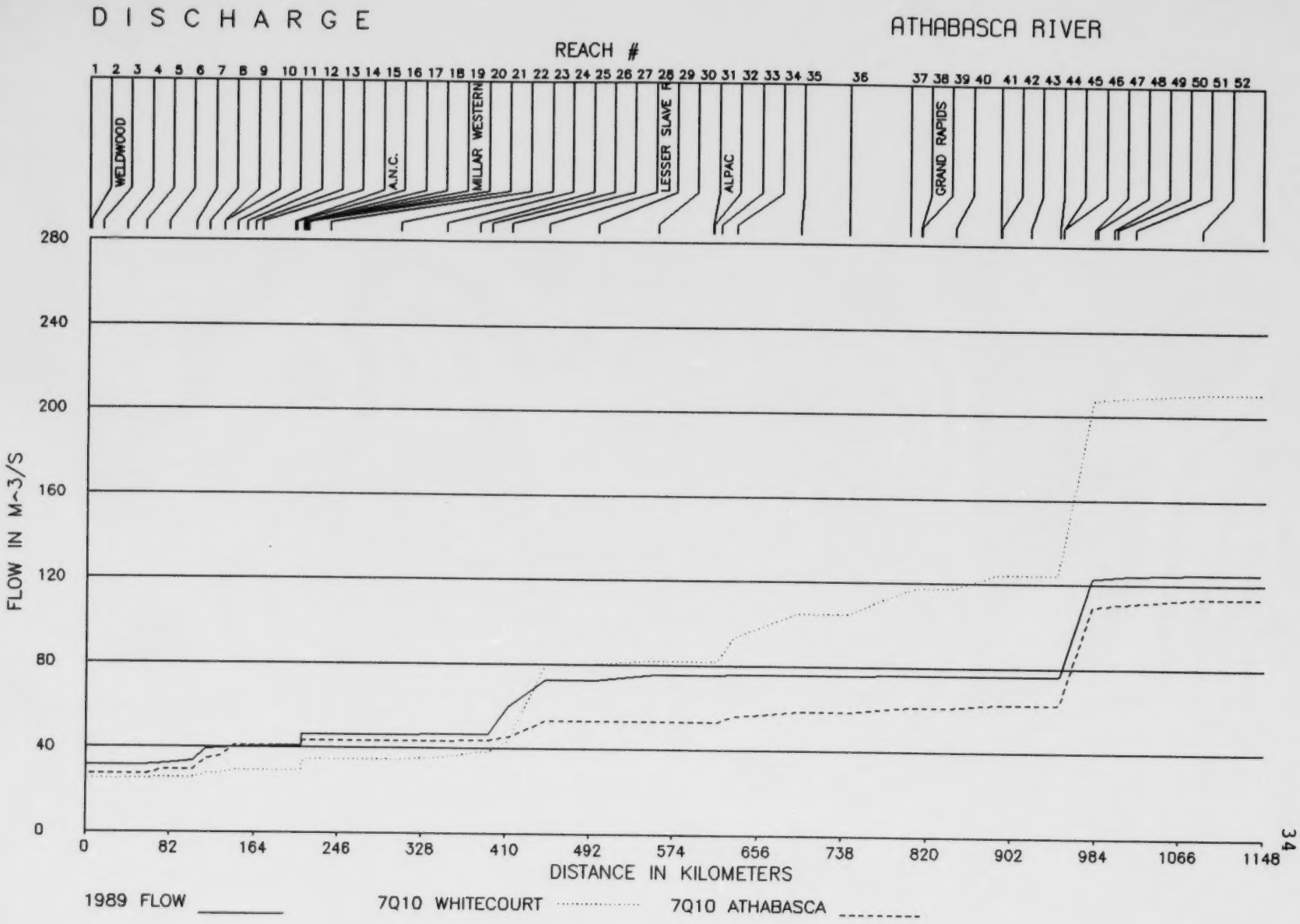


Figure 6.1
HydroQual

Table 6.1 Description of effluent loading scenarios.

		CASE #1	CASE #2	CASE #3	CASE #4	CASE #5	CASE #6
WELDWOOD							
	ADT/DAY	595	532	565	1100	1100	1100
	KG/ADT BOD5	5	3.5	11.7	7	2	3
	KG/DAY BOD5	2949	1842	6610	7700	2200	3300
ANC							
	ADT/DAY	-	-	-	700	700	700
	KG/ADT BOD5	-	-	-	3	2	3
	KG/DAY BOD5	-	-	-	2100	1400	2100
MILLAR WESTERN							
	ADT/DAY	-	512	680	680	680	680
	KG/ADT BOD5	-	11.7	7.5	7.5	2	3
	KG/DAY BOD5	-	5967	5100	5100	1360	2040
A.E.C.							
	ADT/DAY	-	-	-	350	350	350
	KG/ADT BOD5	-	-	-	5	2	3
	KG/DAY BOD5	-	-	-	1750	700	1050
ALPAC							
	ADT/DAY	-	-	-	-	1500	1500
	KG/ADT BOD5	-	-	-	-	2	3
	KG/DAY BOD5	-	-	-	-	3000	4500
TOTAL							
	ADT/DAY	595	1044	1245	2830	4330	4330
	KG/DAY BOD5	2949	7809	11710	16650	8660	12990

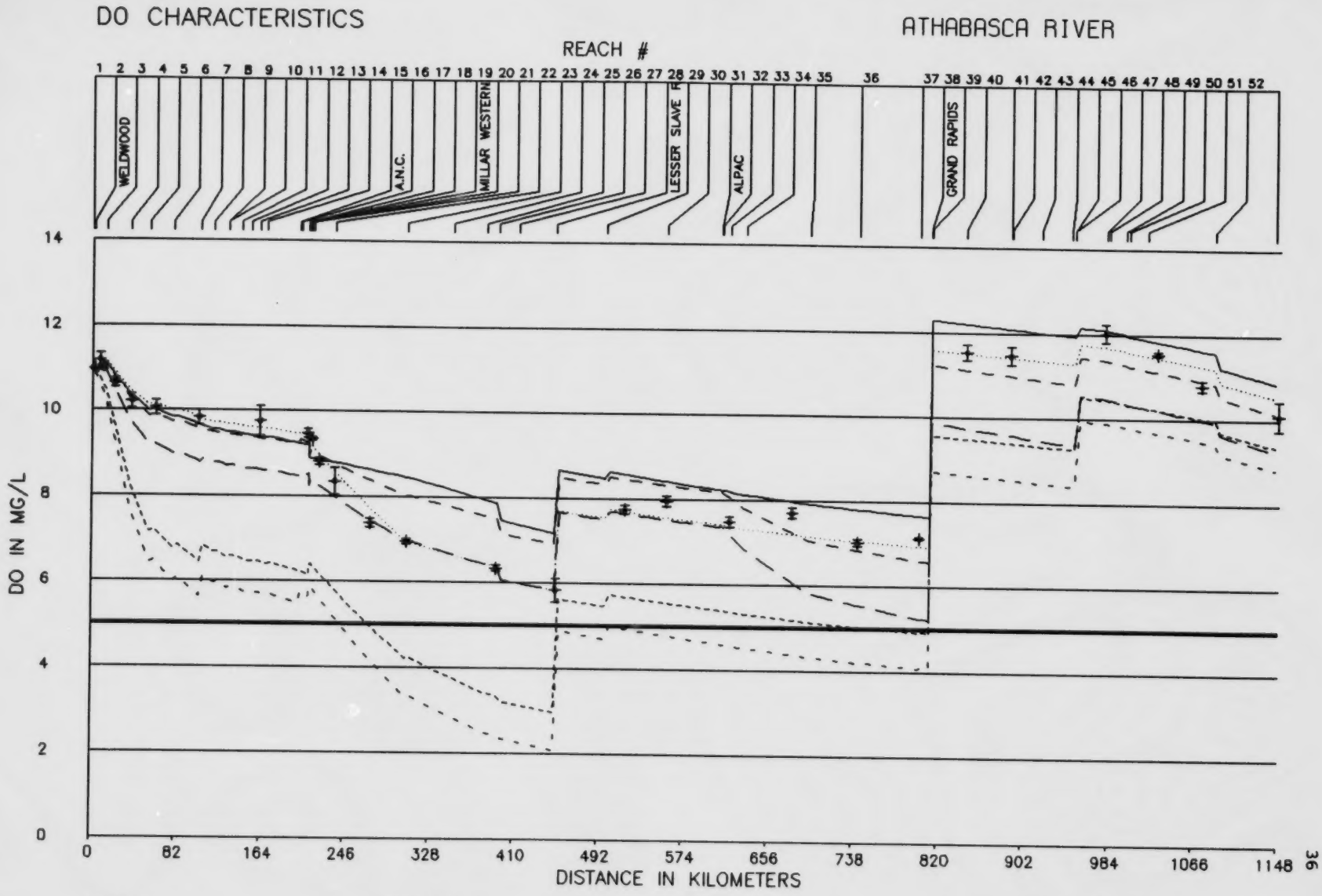
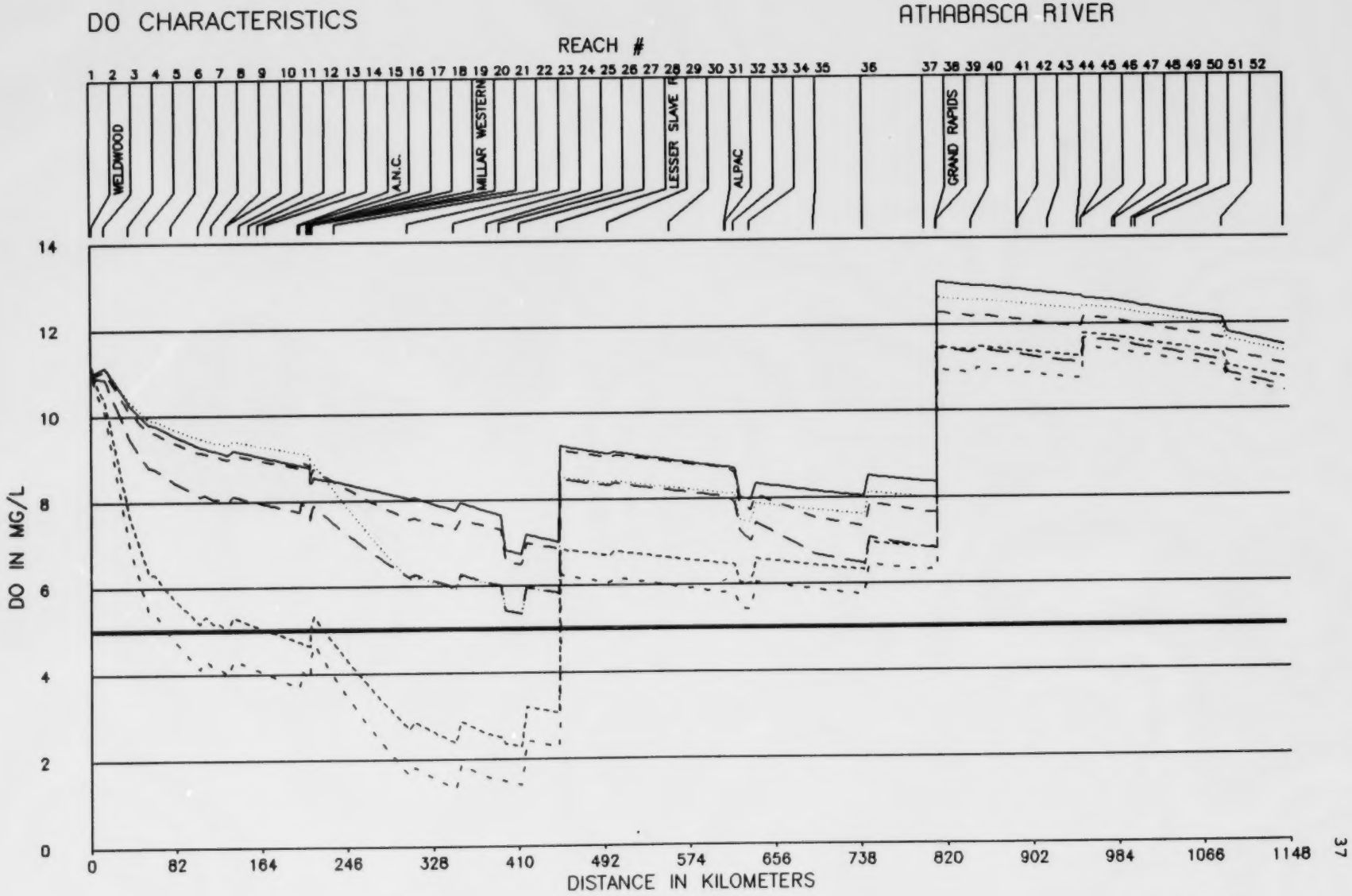

DO CHARACTERISTICS
ATHABASCA RIVER
REACH #
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52
WELDWOOD
A.N.C.
MILLAR WESTERN
LESSER SLAVE R.
ALPAC
GRAND RAPIDS
DO IN MG/L
0 2 4 6 8 10 12 14
0 82 164 246 328 410 492 574 656 738 820 902 984 1066 1148
DISTANCE IN KILOMETERS
CASE #1
CASE #2
CASE #3
CASE #4
CASE #5
CASE #6
OBSERVED
OBJECTIVE
1989 OBSERVED FLOWS [89.08.11]

Figure 6.2
HydroQual



7Q10 FLOWS - WHITECOURT [89.08.11]

Figure 6.3
HydroQual

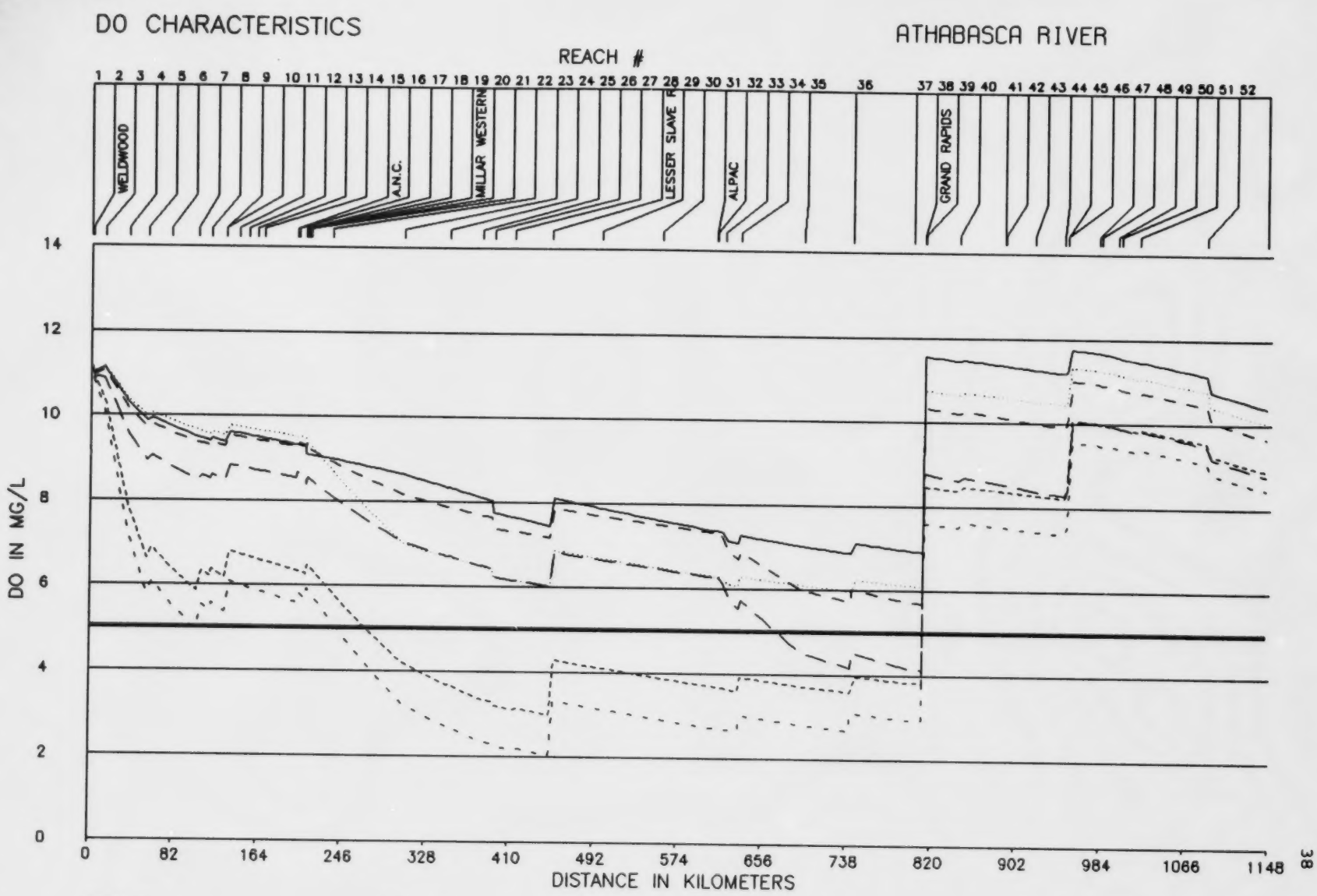


Figure 6.4
HydroQual

at kilometer 1.7, A.N.C. at kilometer 202, Millar Western at 211, A.E.C. via the Lesser Slave River at kilometer 449, and ALPAC at kilometer 609.

With the 1989 observed flow condition, loading Case #3 (current maximum permitted) and Case #4 (Weldwood expansion) the Athabasca River dissolved oxygen goes well below the Alberta surface water quality objective of 5.0 mg/L. Both recover to above or near 5.0 mg/L with the addition of the Lesser Slave River, however, Case #4 continues to decline to 4 mg/L upstream of Grand Rapids. Case #6 (full development, Standard of 3.0 kg/Adt) results approach 5.0 mg/L near Grand Rapids but donot go below. Case #1 (1988 loadings) simulation shows a minimum oxygen level of 7.5 mg/L and Case #2 (1989 Survey #3 calibration) a minimum near 6.0 mg/L.

The trends are similar under Whitecourt 7Q10 (Figure 6.3) with Cases #3 and #4 resulting in dissolved oxygen below 5.0 mg/L upstream of the Lesser Slave River, however, the higher flows in the lower basin, including the inflows between Athabasca and Grand Rapids, enable the results of all loading scenarios to remain above 5.0 mg/L.

Moving from the evaluations using the 1989 observed flows (Figure 6.2) to the Athabasca 7Q10 flows (Figure 6.4), the greatest difference is the reduced change in oxygen downstream of the Lesser Slave River. Flows in the Lesser Slave River under these conditions are very low (7.5 m^3/s versus 22.7 in 1989 and 31.3 in the Whitecourt 7Q10 condition and consequently Cases #3 and #4 results remain below 5.0 mg/L from downstream Whitecourt (km 240) to Grand Rapids (km 810). The beneficial effect of the inflows between Athabasca and Grand Rapids is also evident under these flow conditions.

These results suggest that under a full pulp mill development scenario and the three flow conditions, an effluent standard of 3.0 kg/Adt or less would be required for all mills except ALPAC

which would require a standard of 2.0 kg/Adt or less, in order to meet the objective of 5.0 mg/L dissolved oxygen for all three flow conditions.

7.0 DISCUSSION

The extensive information collected over the winters of 1988 and 1989 have provided an excellent information base from which to calibrate the water quality model DOSTOC for the Athabasca River. This information base collected before and after the addition of a major industrial discharge (Millar Western), provides a perfect situation for model calibration.

Below Millar Western there is a very rapid consumption of oxygen, much faster than any observed BOD oxidation rates, and a corresponding rapid decrease in water column BOD. This has been modelled as BOD settling or adsorption and sediment oxygen demand, and has adequately simulated the oxygen profile. While this approach is a better representation of reality it is more difficult to check (SOD and BOD settling under-ice are very difficult to measure) and more difficult to model.

The long-term BOD data should continue to be analyzed to determine if the effluent oxidation can be better described with a two-component model. If this is possible, more of the rapid oxygen demand immediately below the mill discharge could then be attributed to water column versus sediment oxygen demand. If a two-component oxidation model is not possible then it will add support to the existing calibration.

Regardless of the oxygen demand distribution, water column or sediment, a calibration which can simulate all five calibration intervals (which this calibration does) will provide a robust model.

Extending the model calibrations to evaluate future pulp mill effluent effects on river dissolved oxygen requires assumptions regarding how the effluent BOD will behave, oxidation, settling and SOD rates. Fortunately there are data for BOD kinetics below both

a kraft processing mill and a CTMP mill which can logically be applied to mills employing similar processing.

Results of the scenario evaluations are as expected, any large increase in BOD loading to the Athabasca River beyond the 1989 levels (where river oxygen levels went below 6.0 mg/L) will cause the river oxygen to go below 5.0 mg/L.

Despite the fact that assumptions had to be made in both the calibration and scenario evaluations, the model predictions are made with reasonable certainty. While finalizing the model calibration, numerous different approaches and assumptions were tried and regardless of the technique, when the full development scenarios were used in each of the calibrated models the comparable results were within 0.5 mg/L.

8.0 REFERENCES

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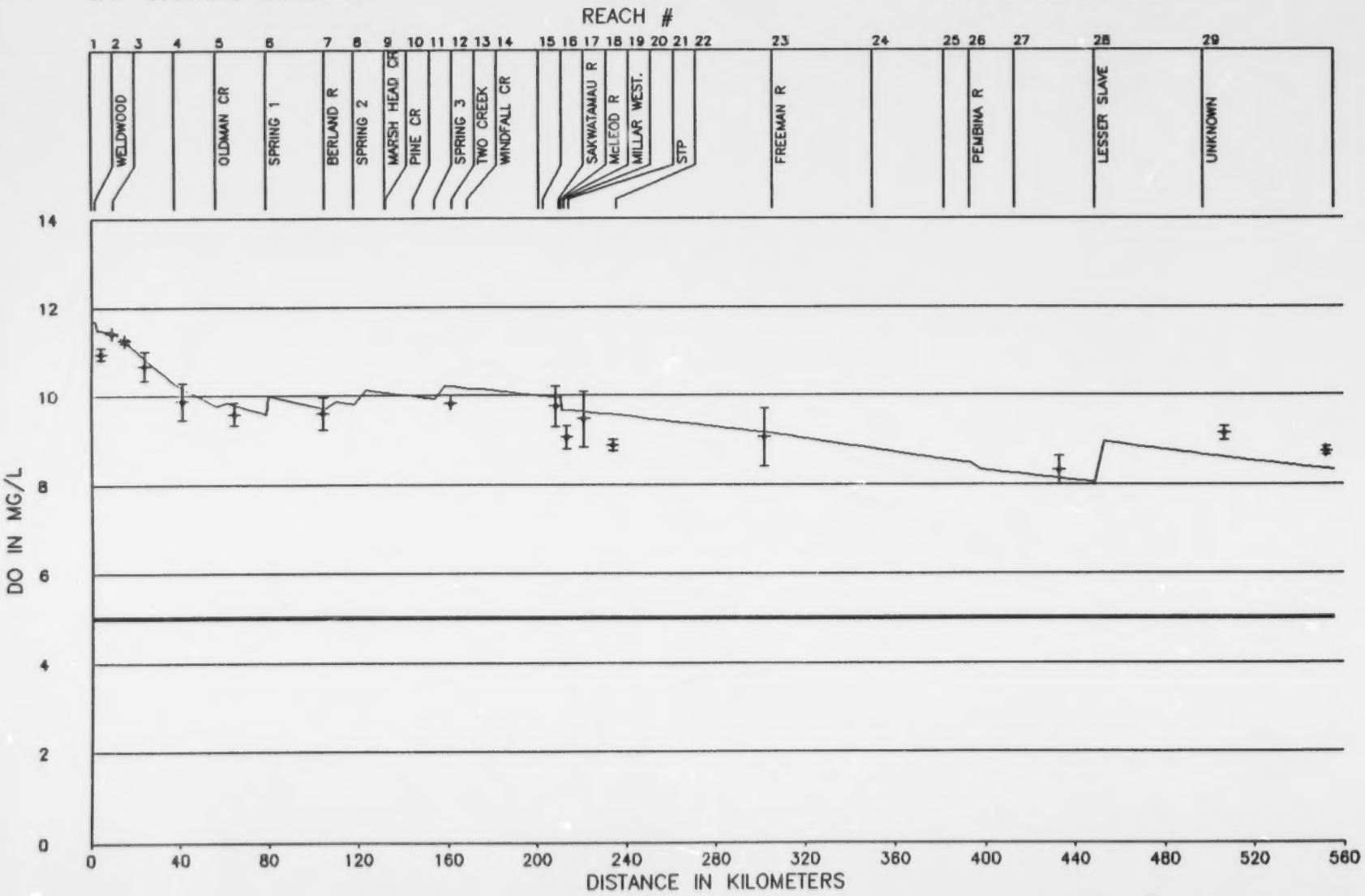
APPENDIX 1 - MODEL CALIBRATION RESULTS

February 1988	-	Hinton to Athabasca
March 1988	-	Hinton to Athabasca
Survey #1 1989	-	Hinton to Lake Athabasca
Survey #2 1989	-	Whitecourt to Athabasca
Survey #3 1989	-	Hinton to Lake Athabasca

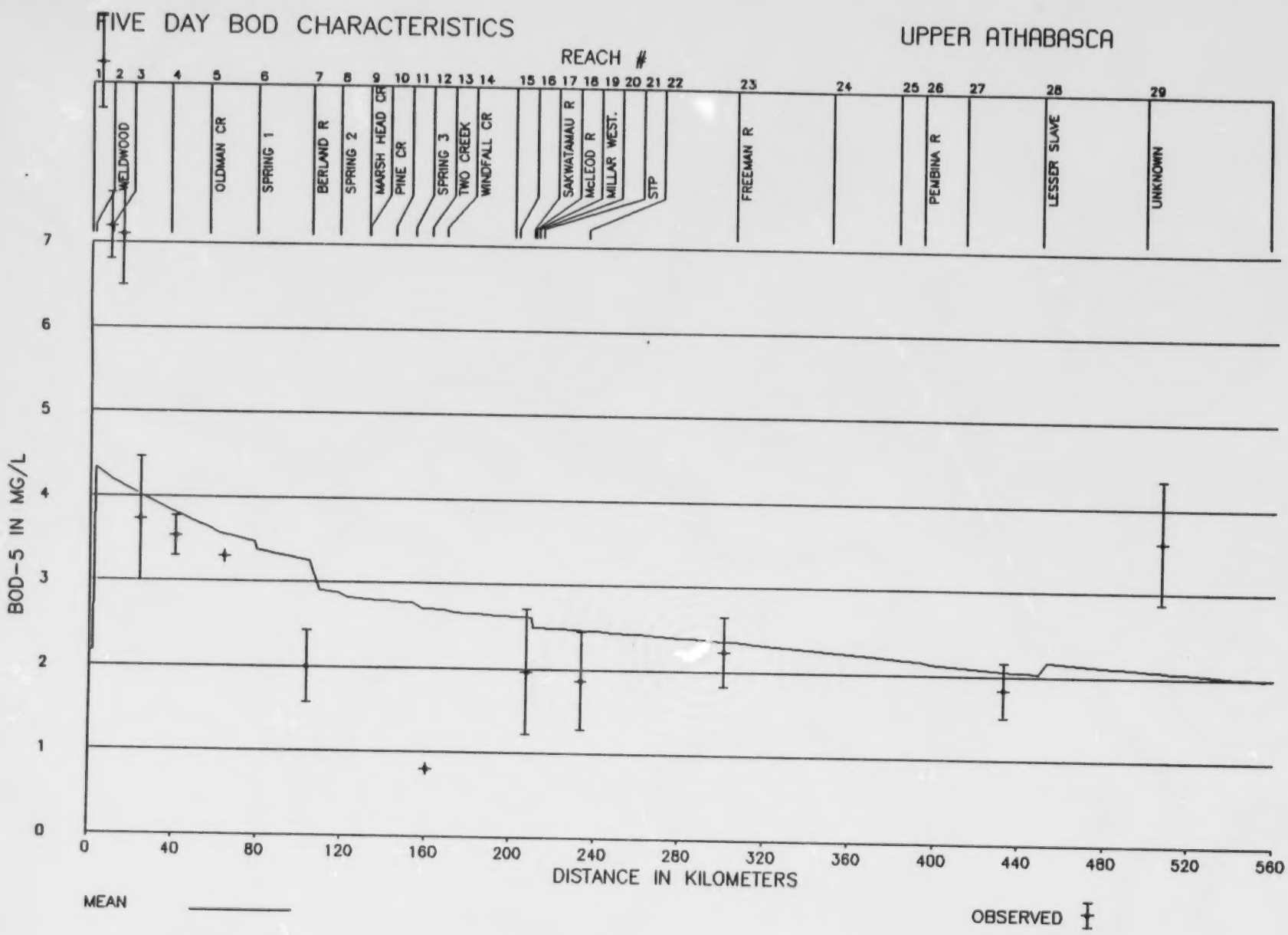
DO CHARACTERISTICS

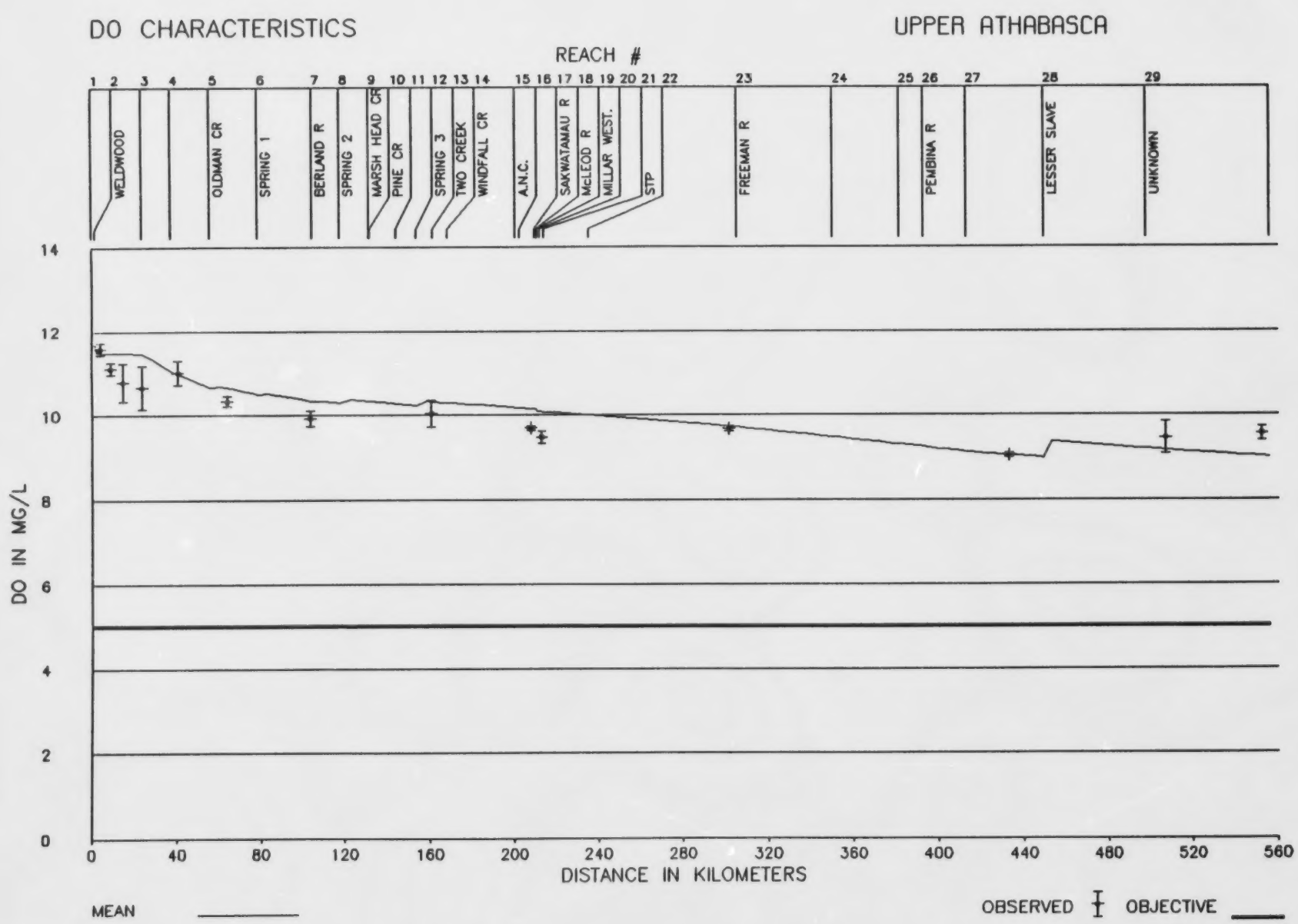
UPPER ATHABASCA



FEBRUARY 1988 [89.06.13]

HydroQual


FIVE DAY BOD CHARACTERISTICS
UPPER ATHABASCA
REACH #
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
WELDWOOD
OLDMAN CR
SPRING 1
BERLAND R
SPRING 2
MARSH HEAD CR
PINE CR
SPRING 3
TWO CREEK
WINDFALL CR
SAKWATAMAU R
McLEOD R
MILLAR WEST.
STP
FREEMAN R
PEMBINA R
LESSER SLAVE
UNKNOWN
BOD-5 IN MG/L
0 1 2 3 4 5 6 7
0 40 80 120 160 200 240 280 320 360 400 440 480 520 560
DISTANCE IN KILOMETERS
MEAN
OBSERVED
FEBRUARY 1988 [89.06.13]
HydroQual

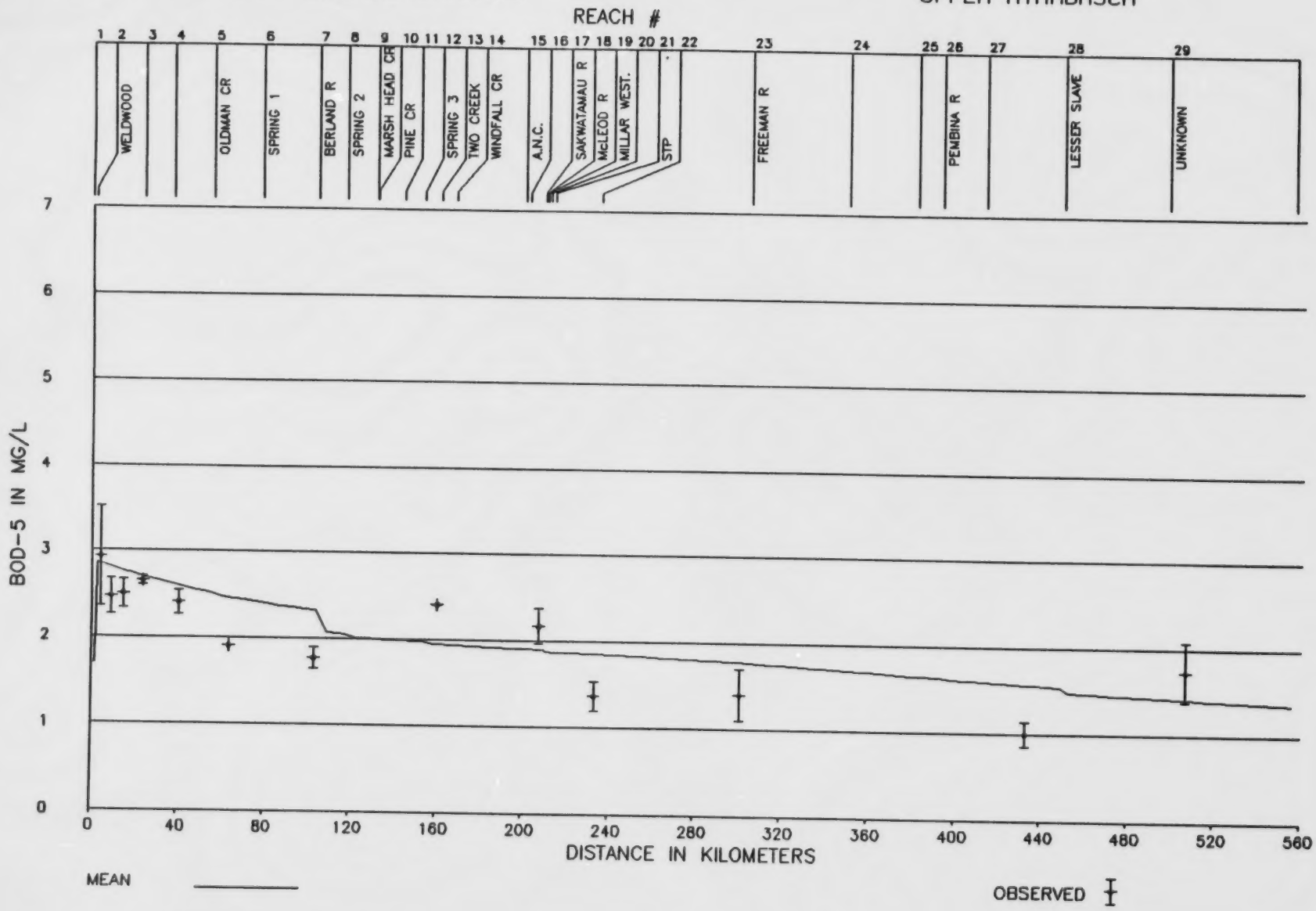


MARCH 1988 [89.06.13]

Figure 5.1
HydroQual

FIVE DAY BOD CHARACTERISTICS

UPPER ATHABASCA

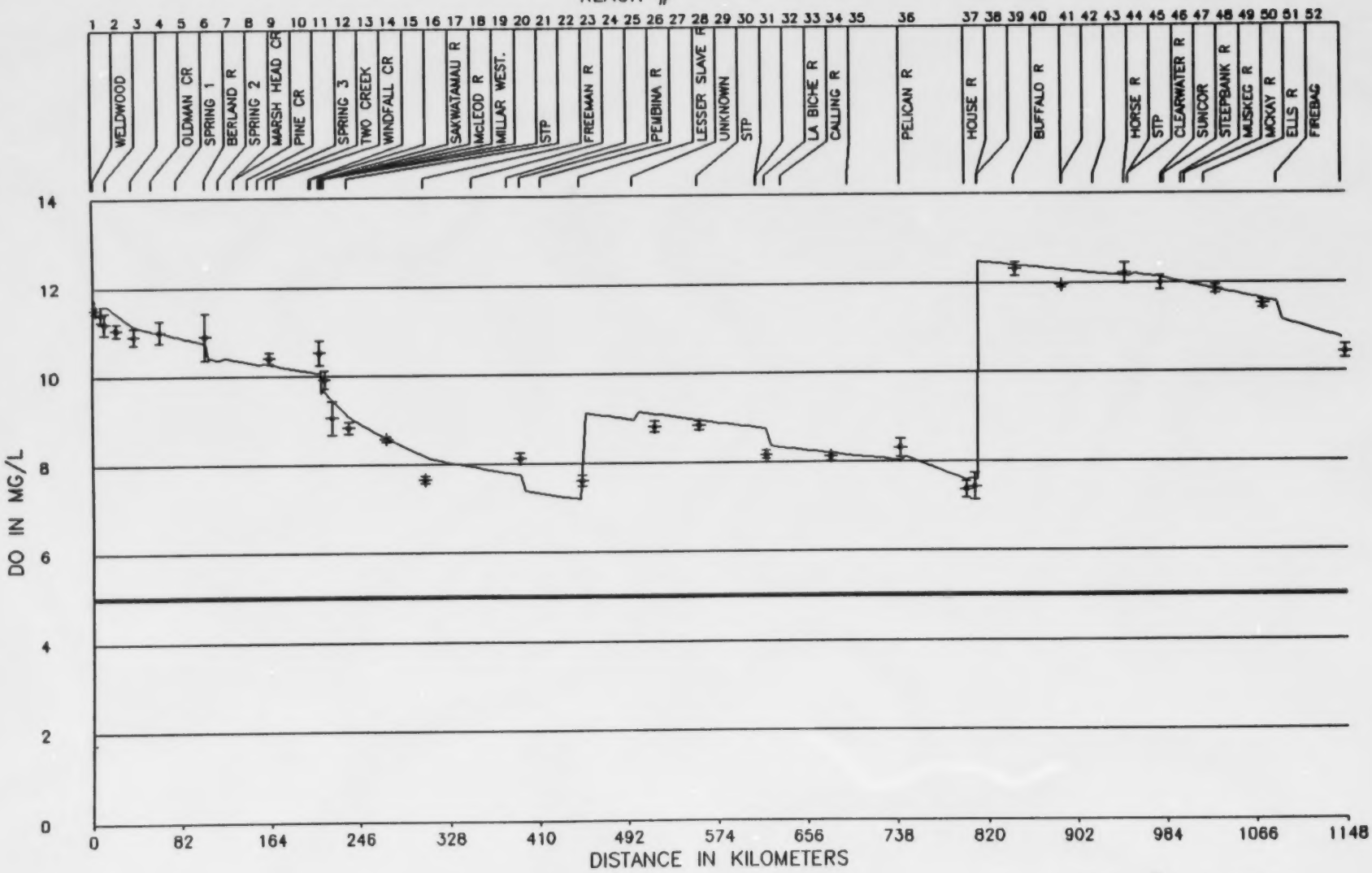


MARCH 1988 [89.06.13]

HydroQual

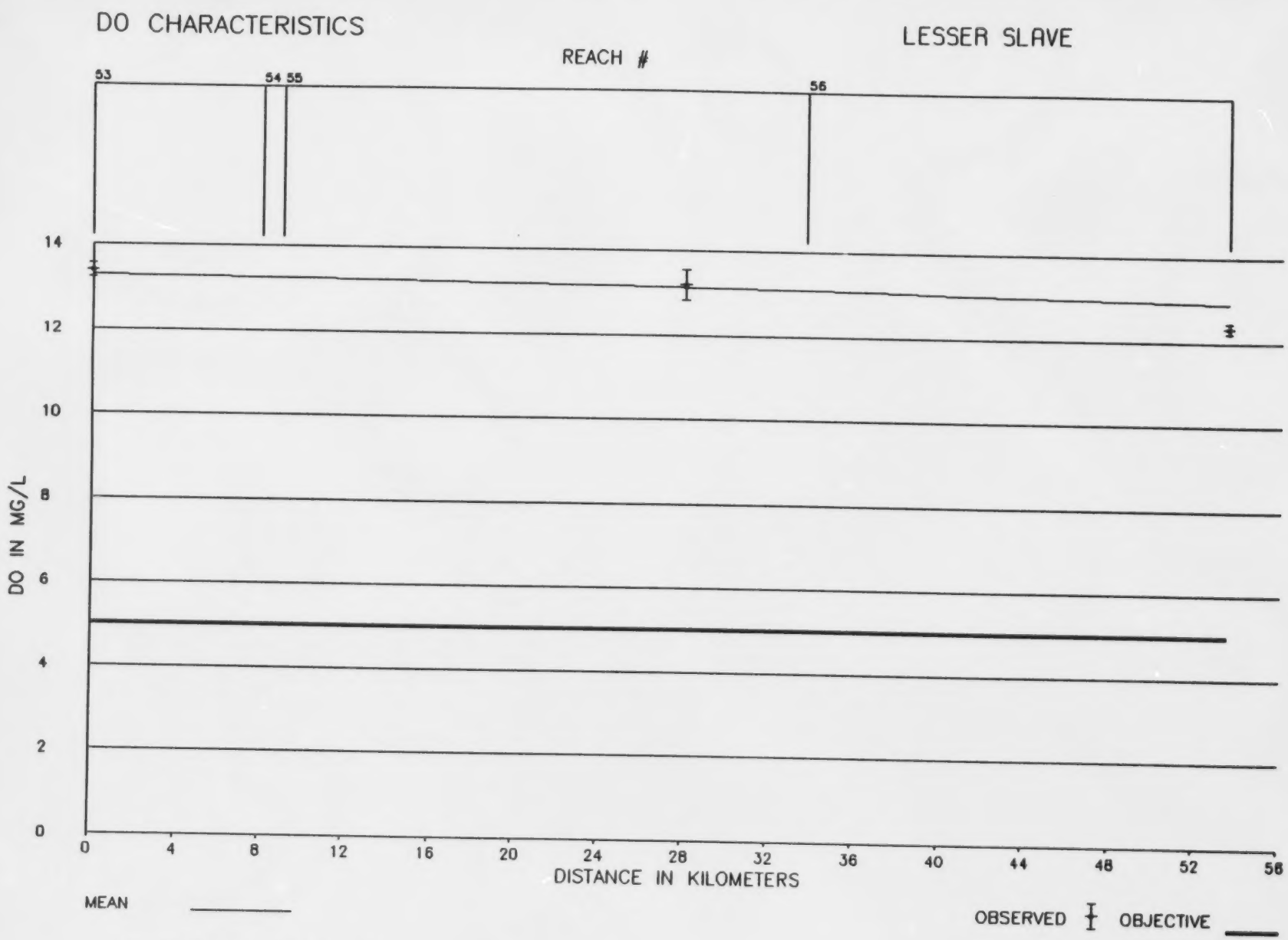
DO CHARACTERISTICS

ATHABASCA RIVER



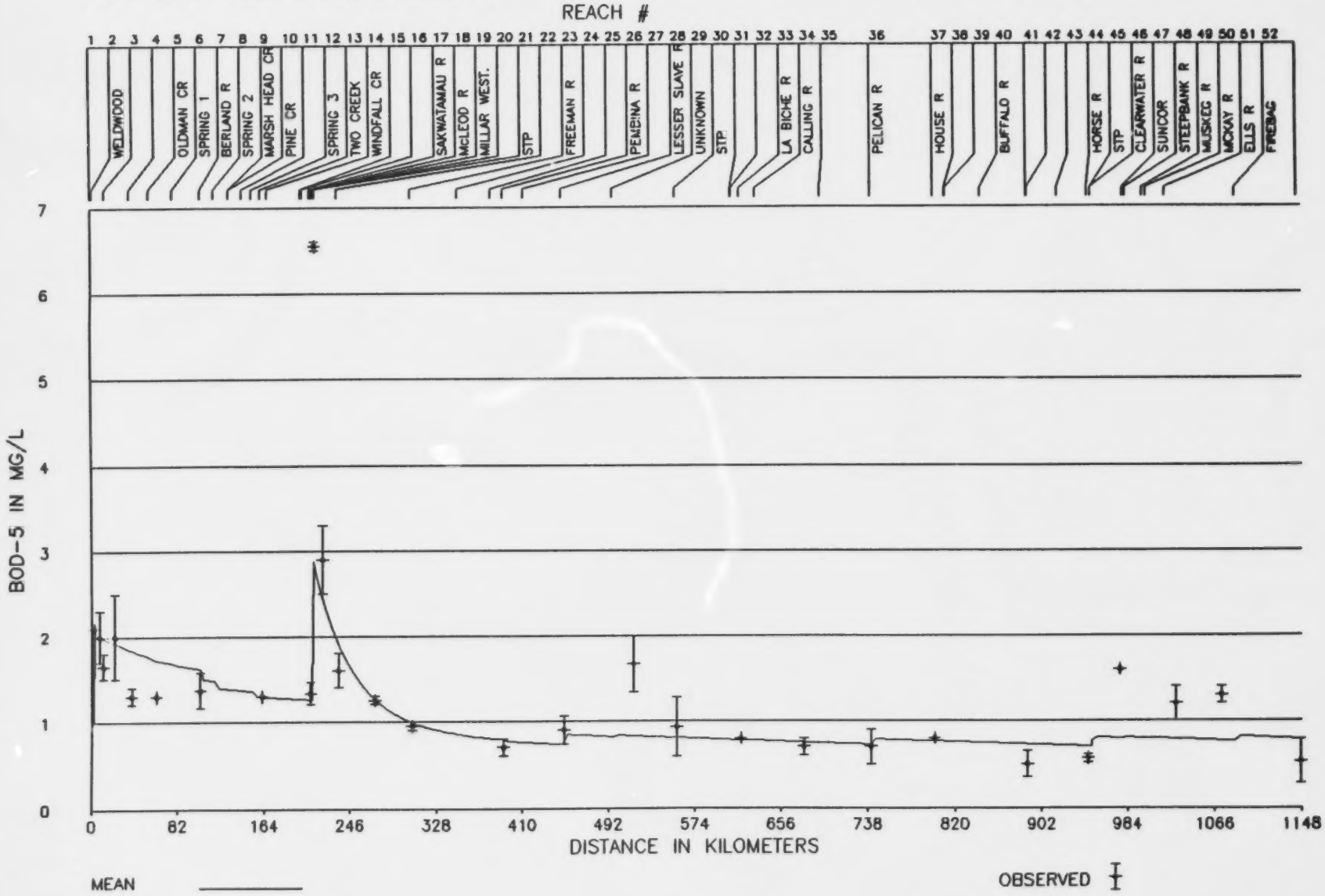
SURVEY #1 1989 [89.06.13]

HydroQual


DO CHARACTERISTICS
LESSER SLAVE
REACH #
53
54 55
56
14
12
10
8
6
4
2
0
DO IN MG/L
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
DISTANCE IN KILOMETERS
MEAN
OBSERVED
OBJECTIVE
SURVEY #1 1989 [89.06.13]
HydroQual

FIVE DAY BOD CHARACTERISTICS

ATHABASCA RIVER

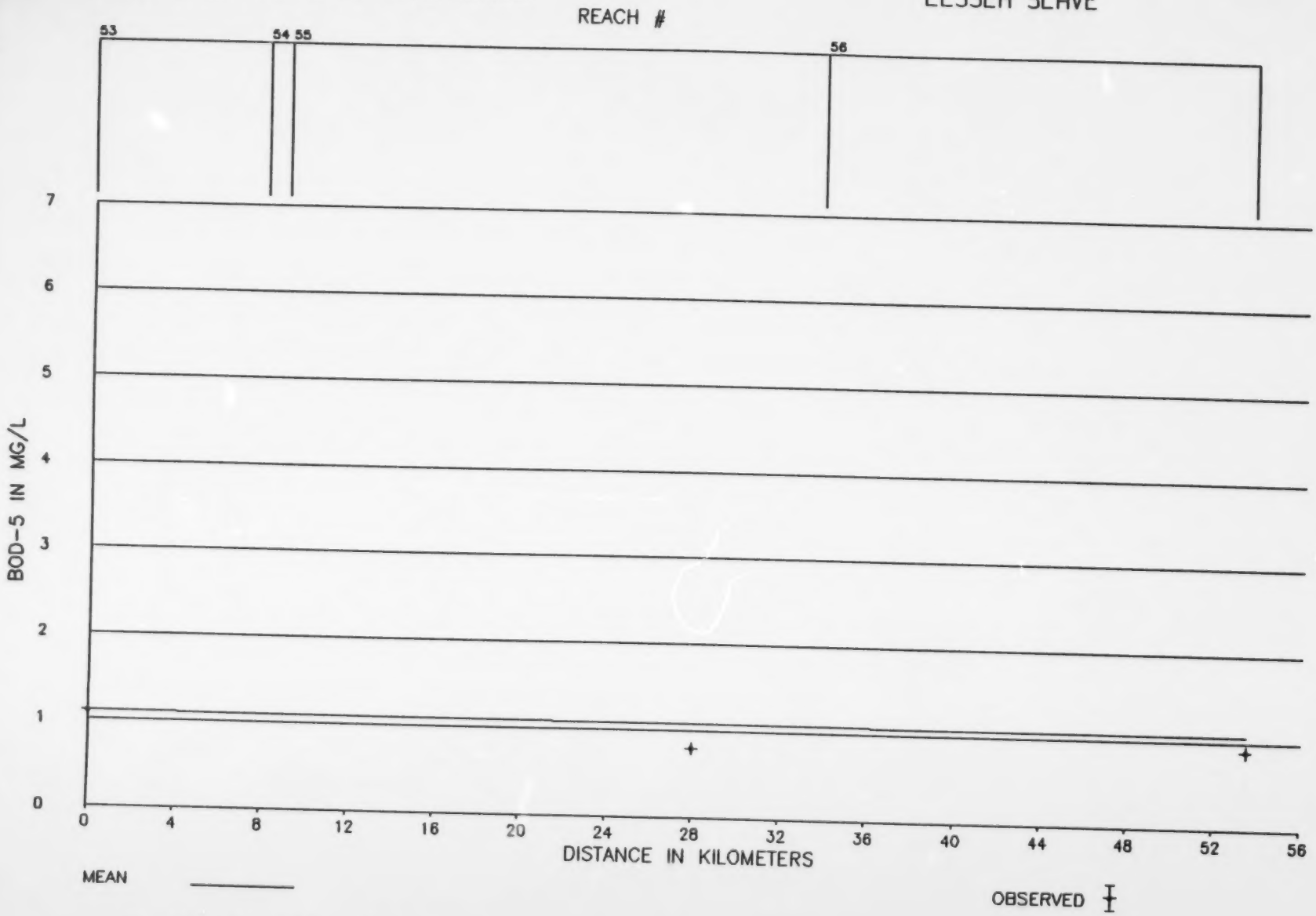


SURVEY #1 1989 [89.06.13]

HydroQual

FIVE DAY BOD CHARACTERISTICS

LESSER SLAVE

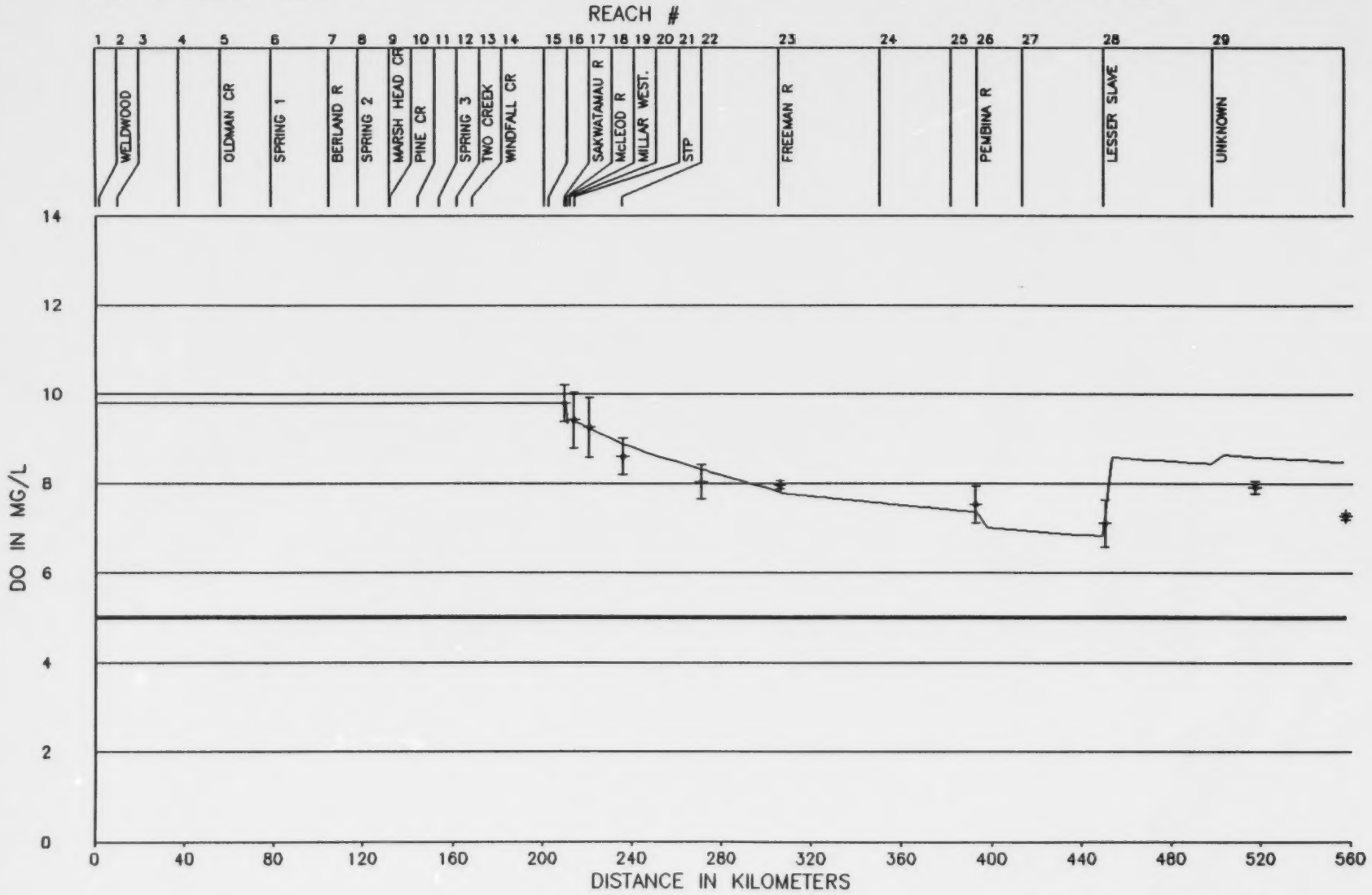


SURVEY #1 1989 [89.06.13]

HydroQual

DO CHARACTERISTICS

UPPER ATHAB

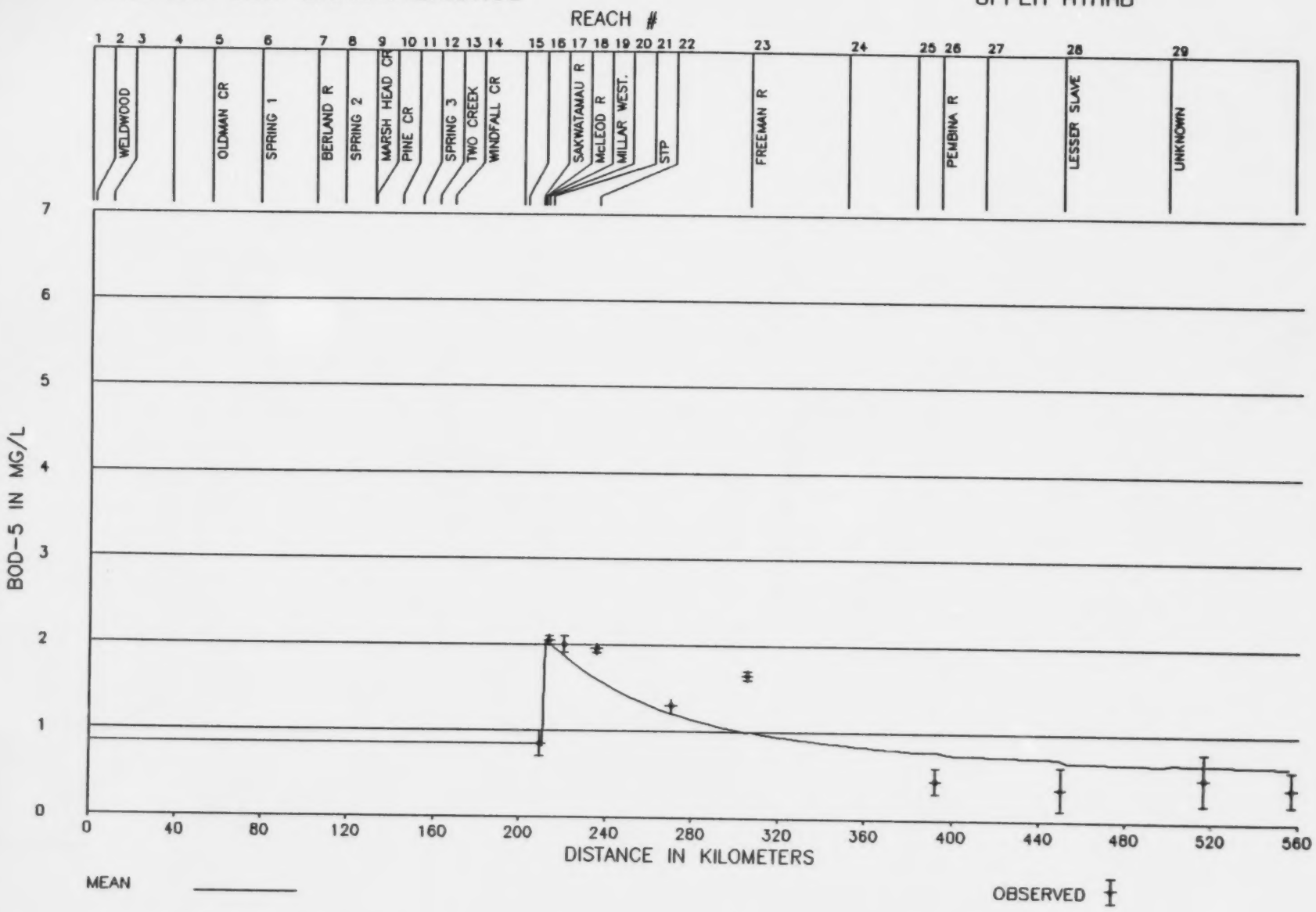


SURVEY #2 [89.06.13]

HydroQual

FIVE DAY BOD CHARACTERISTICS

UPPER ATHAB

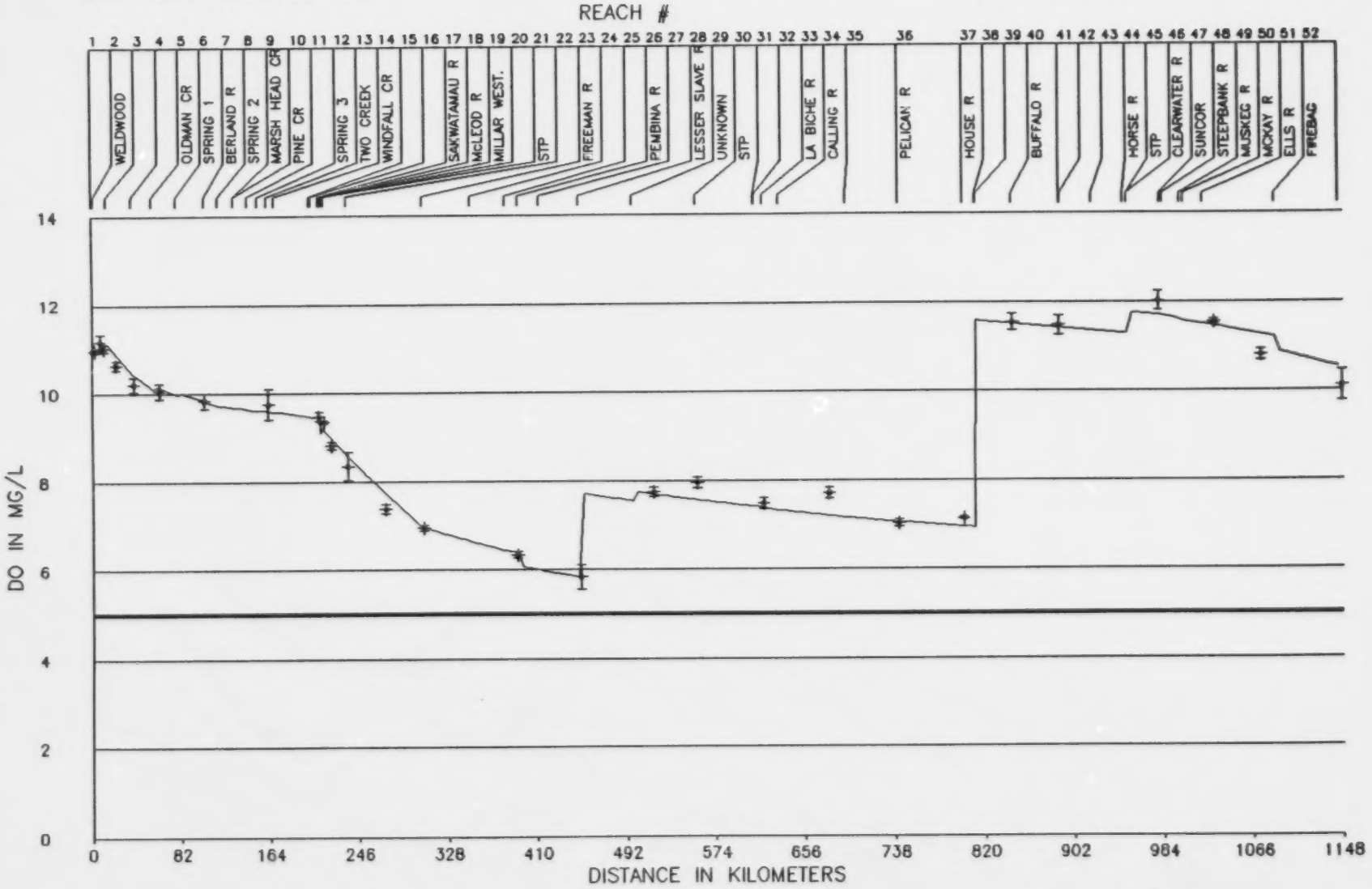


SURVEY #2 1989 [89.06.13]

HydroQual

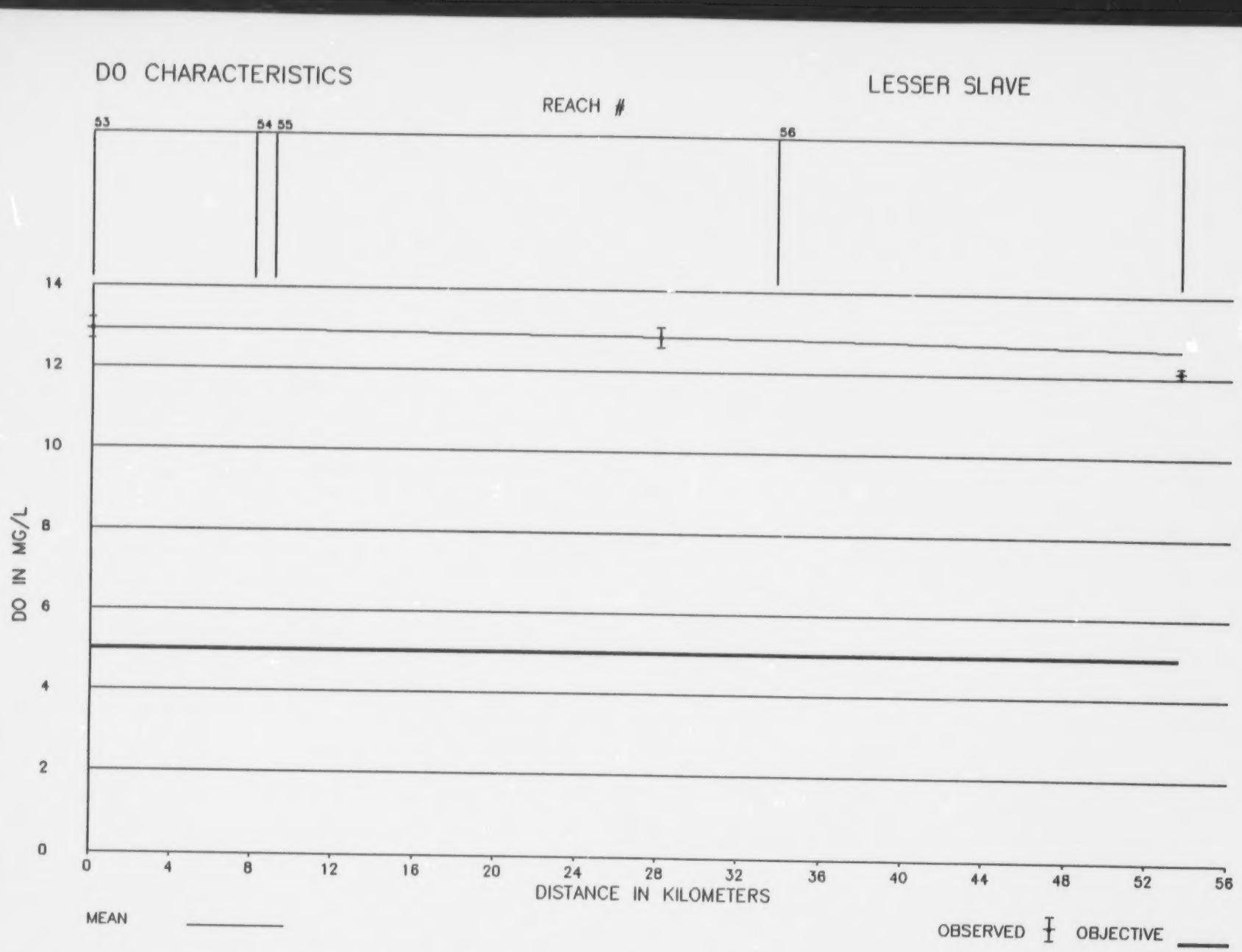
DO CHARACTERISTICS

ATHABASCA RIVER



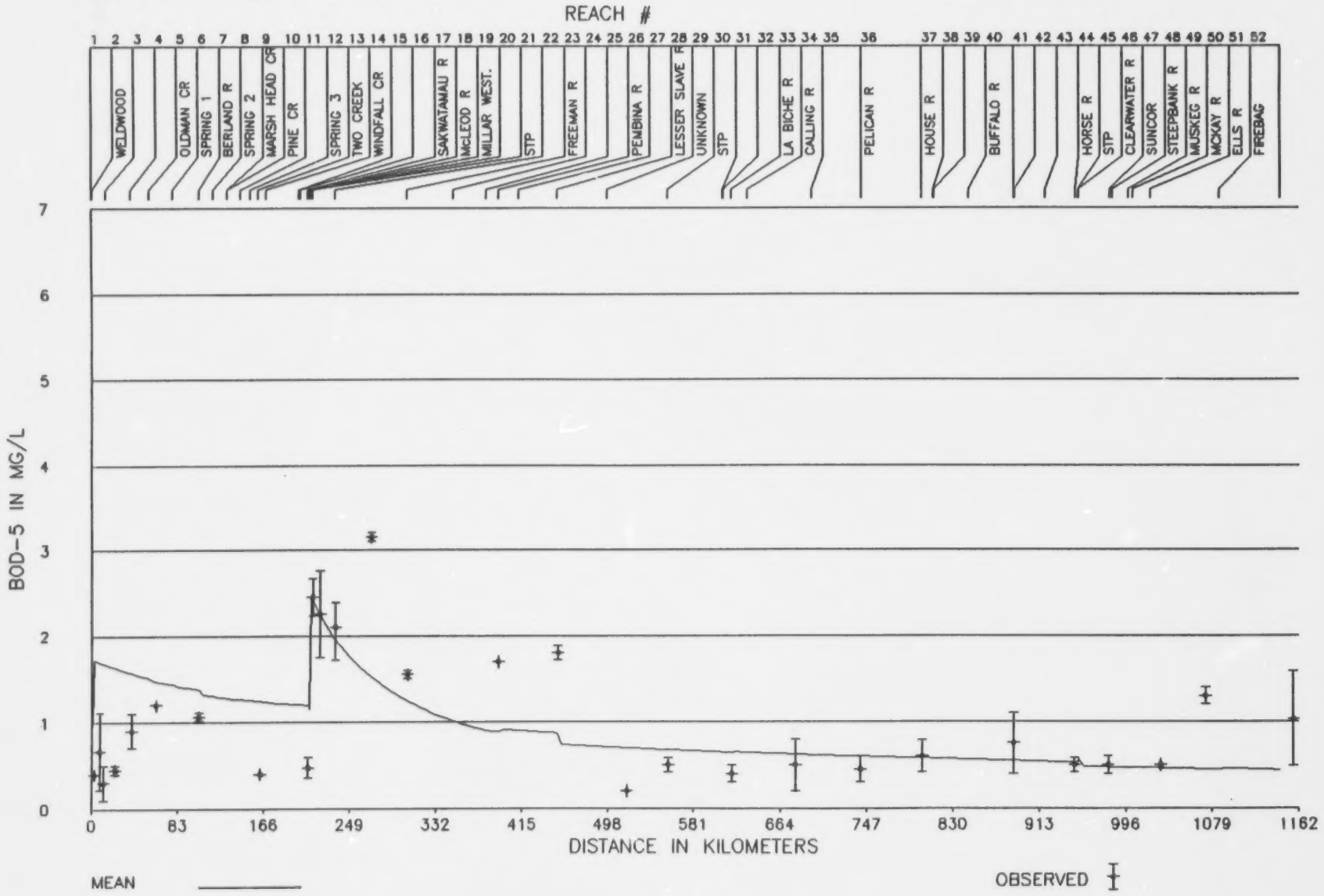
SURVEY #3 1989 [89.06.13]

HydroQual


DO CHARACTERISTICS
LESSER SLAVE
REACH #
53
54 55
56
14
12
10
8
6
4
2
0
DO IN MG/L
0
4
8
12
16
20
24
28
32
36
40
44
48
52
56
DISTANCE IN KILOMETERS
MEAN
OBSERVED
OBJECTIVE
SURVEY #3 1989 [89.06.13]
HydroQual

FIVE DAY BOD CHARACTERISTICS

ATHABASCA RIVER

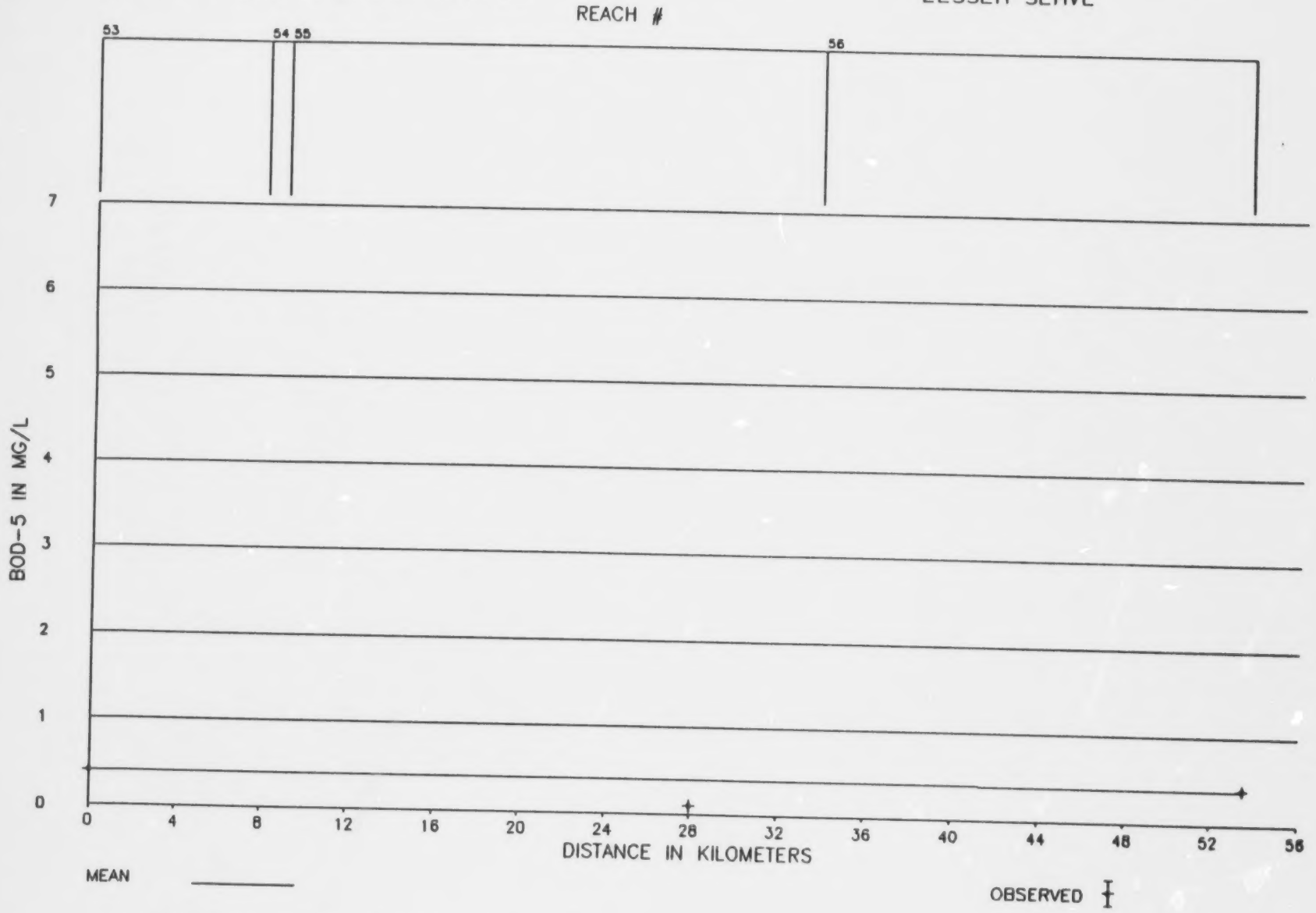


SURVEY #3 1989 [89.06.13]

HydroQual

FIVE DAY BOD CHARACTERISTICS

LESSER SLAVE



SURVEY #3 1989 [89.06.13]

HydroQual

APPENDIX 2.1 - MODEL INPUT FILES - CALIBRATION

Filename	Description	
UD0288C1.DIN	February 1988 -	Hinton to Athabasca
UD0388C1.DIN	March 1988 -	Hinton to Athabasca
0189C1.DIN	Survey #1 1989 -	Hinton to Embarras
UD0289C1.DIN	Survey #2 1989 -	Whitecourt to Athabasca
0389C1.DIN	Survey #3 1989 -	Hinton to Embarras

UPPER ATHABASCA - FEBRUARY 1988 CALIB (C1) - JUNE 13, 1989

NRT	NTRIB	MAXTR	MAXRI	MAXPT	NSTP	NVAR
29	0	0	29	29	18	9

GROUP 2 (ONE LINE FOR EACH REACH)

IRCH	UP1	IUP2	X	Q	QLD	SOURCE NAME
1	0	0	1.7	25.1	0.000	
2	1	0	8.5	24.176	0.924	WELDWOOD <==OPEN
3	2	0	27.3	25.1	0.000	
4	3	0	18.6	25.1	0.000	
5	4	0	22.5	25.1	0.908	OLDMAN CR
6	5	0	25.8	26.008	2.96	SPRING 1
7	6	0	13.3	28.968	6.43	BERLAND R
8	7	0	13.8	35.398	5.92	SPRING 2
9	8	0	0.2	41.318	0.000	MARSH CR
10	9	0	12.7	41.318	0.000	PINE CR
11	10	0	9.2	41.318	0.000	
12	11	0	8.0	41.318	5.92	SPRING 3
13	12	0	7.0	47.238	0.000	TWO CREEK
14	13	0	32.0	47.238	0.49	WINDFALL
15	14	0	2.0	47.728	0.000	
16	15	0	6.7	47.728	0.000	
17	16	0	1.1	47.728	0.582	SAKWATAMAU
18	17	0	0.1	48.31	3.68	McLEOD R
19	18	0	1.5	51.99	0.000	MILLAR WEST.<==OPEN
20	19	0	2.1	51.99	0.000	
21	20	0	21.1	51.99	0.000	WHITE STP
22	21	0	70.0	51.99	0.000	
23	22	0	44.6	51.99	0.118	FREEMAN R.
24	23	0	31.5	52.108	0.000	
25	24	0	11.5	52.108	0.000	
26	25	0	20.0	52.108	1.02	PEMBINA R.
27	26	0	36.1	53.128	0.000	
28	27	0	48.7	53.128	12.3	LESSER SLAVE R.
29	28	0	58.4	65.428	0.000	UNKNOWN

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

STNAM	INST
WELDWOOD	2
OLDMAN CR	5
SPRING 1	6
BERLAND R	7
SPRING 2	8
MARSH HEAD CR	9
PINE CR	10
SPRING 3	12
TWO CREEK	13
WINDFALL CR	14
SAKWATAMAU R	17
McLEOD R	18
MILLAR WEST.	19
STP	21

FREEMAN R	23
PEMBINA R	26
LESSER SLAVE	28
UNKNOWN	29

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)
RNAM
****
UPPER ATHABASCA

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)
TNAM INTR
****

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH	XLD1	XLD2	XLD3	XLD4	XLD5	XLD6	XLD7	XLD8	XLD9
1	0	0	0	0	0	0	0	0	0
2	276.0	6.3	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	13.8	16.64	0	0	0	0	0	0
6	0	13.8	16.64	0	0	0	0	0	0
7	0	10.89	8.96	0	0	0	0	0	0
8	0	12.51	16.64	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	12.51	14.56	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0
14	0	12.51	4.48	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
17	0	13.8	16.64	0	0	0	0	0	0
18	0	5.54	6.4	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0
23	0	8.65	11.52	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0
26	0	2.21	7.04	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0
28	0	13.03	17.92	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0

GROUP 7 (ONE LINE FOR EACH HEADWATER)

X01	X02	X03	X04	X05	X06	X07	X08	X09
0.0	11.69	13.89	0	0	0	0	0	0

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

REACH	XK1	XK2	XK3	XK4	XM1	XM2	XM3	XRES	XDS	XP

1	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
2	0.035	0.58	.15	.020	.00	.00	.000	.65	13.0	.001
3	0.035	0.03	.1	.020	.00	.00	.000	.55	13.0	.001
4	0.035	0.03	.1	.020	.00	.00	.000	.35	13.0	.001
5	0.035	0.03	.05	.020	.00	.00	.000	.10	13.0	.001
6	0.035	0.03	.05	.020	.00	.00	.000	.07	13.0	.001
7	0.035	0.03	.05	.020	.00	.00	.000	.07	13.0	.001
8	0.035	0.03	.05	.020	.00	.00	.000	.07	13.0	.001
9	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
10	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
11	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
12	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
13	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
14	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
15	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
16	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
17	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
18	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
19	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
20	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
21	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
22	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
23	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
24	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
25	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
26	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
27	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
28	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001
29	0.035	0.03	.000	.020	.00	.00	.000	.001	13.0	.001

GROUP 9 (AVERAGE RIVER TEMPERATURE)

TEMPER

****

0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)

REACH	REFQ	T	HEXN	VEXN	RFDGR
**********					
1	50	.045	.516	.353	0
2	50	.196	.512	.344	0
3	50	.722	.516	.353	0
4	50	.448	.550	.346	0
5	50	.543	.550	.346	0
6	50	.622	.550	.346	0
7	50	.297	.540	.266	0
8	50	.308	.540	.266	0
9	50	.004	.540	.266	0
10	50	.284	.540	.266	0
11	50	.202	.551	.326	0
12	50	.176	.551	.326	0
13	50	.154	.551	.326	0
14	50	.704	.551	.326	0
15	50	.044	.551	.326	0
16	50	.147	.551	.326	0
17	50	.022	.463	.362	0

18	50	.002	.463	.362	0
19	50	.029	.463	.362	0
20	50	.041	.463	.362	0
21	50	.414	.463	.362	0
22	50	1.940	.536	.274	0
23	50	1.799	.523	.288	0
24	50	1.426	.512	.350	0
25	50	.463	.512	.260	0
26	50	.805	.512	.260	0
27	50	1.453	.512	.260	0
28	50	1.960	.512	.260	0
29	50	2.350	.512	.260	0

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)
FNAM
****
ATHAA

UPPER ATHABASCA - MARCH 1988 CALIB (C1) - JUNE 13, 1989

NRT	NTRIB	MAXTR	MAXRI	MAXPT	NSTP	NVAR
29	0	0	29	29	19	9

GROUP 2 (ONE LINE FOR EACH REACH)

IRCH	IUP1	IUP2	X	Q	QLD	SOURCE NAME
1	0	0	1.7	31.0	0.000	
2	1	0	22.5	30.026	0.974	WELDWOOD <==OPEN
3	2	0	13.3	31.0	0.000	
4	3	0	18.6	31.0	0.000	
5	4	0	22.5	31.0	1.33	OLDMAN CR
6	5	0	25.8	32.33	0.90	SPRING 1
7	6	0	13.3	33.23	7.69	BERLAND R
8	7	0	13.8	40.92	4.35	SPRING 2
9	8	0	0.2	45.27	0.000	MARSH CR
10	9	0	12.7	45.27	0.000	PINE CR
11	10	0	9.2	45.27	0.000	
12	11	0	8.0	45.27	4.35	SPRING 3
13	12	0	7.0	49.62	0.000	TWO CREEK
14	13	0	32.0	49.62	0.479	WINDFALL
15	14	0	2.0	50.099	0.000	A.N.C <===OPEN
16	15	0	6.7	50.099	0.000	
17	16	0	1.1	50.099	0.01	SAKWATAMAU
18	17	0	0.1	50.109	7.50	McLEOD R
19	18	0	1.5	57.609	0.000	MILLAR WEST.<==OPEN
20	19	0	2.1	57.609	0.000	
21	20	0	21.1	57.609	0.000	WHITE STP
22	21	0	70.0	57.609	0.000	
23	22	0	44.6	57.609	0.151	FREEMAN R.
24	23	0	31.5	57.76	0.000	
25	24	0	11.5	57.76	0.000	
26	25	0	20.0	57.76	1.37	PEMBINA R.
27	26	0	36.1	59.13	0.000	
28	27	0	48.7	59.13	12.6	LESSER SLAVE R.
29	28	0	58.4	71.73	0.000	UNKNOWN

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

STNAM	INST
WELDWOOD	2
OLDMAN CR	5
SPRING 1	6
BERLAND R	7
SPRING 2	8
MARSH HEAD CR	9
PINE CR	10
SPRING 3	12
TWO CREEK	13
WINDFALL CR	14
A.N.C.	15
SAKWATAMAU R	17
McLEOD R	18
MILLAR WEST.	19

STP	21
FREEMAN R	23
PEMBINA R	26
LESSER SLAVE	28
UNKNOWN	29

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)
RNAM
****
UPPER ATHABASCA

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)
TNAM INTR
****

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH	XLD1	XLD2	XLD3	XLD4	XLD5	XLD6	XLD7	XLD8	XLD9
1	0	0	0	0	0	0	0	0	0
2	175.2	5.6	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	12.43	12.1	0	0	0	0	0	0
6	0	12.43	12.1	0	0	0	0	0	0
7	0	10.53	6.6	0	0	0	0	0	0
8	0	11.52	11.0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	11.52	11.0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0
14	0	11.52	11.0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
17	0	12.43	12.1	0	0	0	0	0	0
18	0	9.71	11.0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0
23	0	9.01	7.7	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0
26	0	7.74	8.3	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0
28	0	11.25	7.7	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0

GROUP 7 (ONE LINE FOR EACH HEADWATER)

X01	X02	X03	X04	X05	X06	X07	X08	X09
0.0	11.69	10.89	0	0	0	0	0	0

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

REACH	XK1	XK2	XK3	XK4	XM1	XM2	XM3	XRES	XDS	XP

1	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
2	0.035	0.58	.15	.02	.00	.00	.000	.65	13.0	.001
3	0.035	0.03	.1	.02	.00	.00	.000	.55	13.0	.001
4	0.035	0.03	.1	.02	.00	.00	.000	.35	13.0	.001
5	0.035	0.03	.05	.02	.00	.00	.000	.10	13.0	.001
6	0.035	0.03	.05	.02	.00	.00	.000	.07	13.0	.001
7	0.035	0.03	.05	.02	.00	.00	.000	.07	13.0	.001
8	0.035	0.03	.05	.02	.00	.00	.000	.07	13.0	.001
9	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
10	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
11	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
12	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
13	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
14	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
15	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
16	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
17	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
18	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
19	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
20	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
21	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
22	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
23	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
24	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
25	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
26	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
27	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
28	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001
29	0.035	0.03	.000	.02	.00	.00	.000	.001	13.0	.001

GROUP 9 (AVERAGE RIVER TEMPERATURE)

TEMPER
0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)

REACH	REFQ	T	HEXN	VEXN	RFDGR
1	50	.045	.516	.353	0
2	50	.519	.512	.344	0
3	50	.352	.516	.353	0
4	50	.448	.550	.346	0
5	50	.543	.550	.346	0
6	50	.622	.550	.346	0
7	50	.297	.540	.266	0
8	50	.308	.540	.266	0
9	50	.004	.540	.266	0
10	50	.284	.540	.266	0
11	50	.202	.551	.326	0
12	50	.176	.551	.326	0
13	50	.154	.551	.326	0
14	50	.704	.551	.326	0
15	50	.044	.551	.326	0
16	50	.147	.551	.326	0

17	50	.022	.463	.362	0
18	50	.002	.463	.362	0
19	50	.029	.463	.362	0
20	50	.041	.463	.362	0
21	50	.414	.463	.362	0
22	50	1.940	.536	.274	0
23	50	1.799	.523	.288	0
24	50	1.426	.512	.350	0
25	50	.463	.512	.260	0
26	50	.805	.512	.260	0
27	50	1.453	.512	.260	0
28	50	1.960	.512	.260	0
29	50	2.350	.512	.260	0

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)
FNAM
****
ATHAB

ATHABASCA - SURVEY 1,1989 CALIBRATION <== JUNE 13,1989

NRT	NTRIB	MAXTR	MAXRI	MAXPT	NSTP	NVAR
56	1	4	52	52	33	9

GROUP 2 (ONE LINE FOR EACH REACH)

IRCH	UP1	IUP2	X	Q	QLD	SOURCE NAME
1	0	0	1.7	31.1	0.000	
2	1	0	12.2	30.13	0.970	WELDWOOD <==OPEN
3	2	0	23.6	31.1	0.000	
4	3	0	18.6	31.1	0.000	
5	4	0	22.5	31.1	0.700	OLDMAN CR
6	5	0	25.8	31.8	0.130	SPRING 1
7	6	0	13.3	31.93	5.670	BERLAND R
8	7	0	13.8	37.6	2.205	SPRING 2
9	8	0	0.2	39.805	0.066	MARSH CR
10	9	0	12.7	39.871	0.019	PINE CR
11	10	0	9.2	39.89	0.000	
12	11	0	8.0	39.89	2.200	SPRING 3
13	12	0	7.0	42.09	0.010	TWO CREEK
14	13	0	32.0	42.1	0.503	WINDFALL
15	14	0	2.0	42.603	0.000	
16	15	0	6.7	42.603	0.000	
17	16	0	1.1	42.603	0.560	SAKWATAMAU
18	17	0	0.1	43.163	4.760	McLEOD R
19	18	0	1.5	47.782	0.141	MILLAR WEST.<==OPEN
20	19	0	2.1	47.923	0.000	
21	20	0	21.1	47.887	0.036	WHITE STP
22	21	0	70.0	47.923	0.000	
23	22	0	44.6	47.923	0.480	FREEMAN R.
24	23	0	31.5	48.403	0.000	
25	24	0	11.5	48.403	0.0000	
26	25	0	20.0	48.403	3.597	PEMBINA
27	26	0	36.1	52.0	0.0000	
28	27	56	48.7	79.1	0.0000	LESSER SLAVE
29	28	0	58.4	79.1	6.2	UNKNOWN
30	29	0	53.0	85.288	0.012	ATHAB STP
31	30	0	1.0	85.3	0.0000	
32	31	0	7.4	85.3	0.0000	
33	32	0	15.5	85.3	4.725	LA BICHE
34	33	0	61.5	90.029	0.031	CALLING
35	34	0	47.3	90.06	0.0000	
36	35	0	58.3	90.06	2.344	PELICAN
37	36	0	10.8	92.4	1.2	HOUSE
38	37	0	1.0	93.6	0.0000	
39	38	0	33.3	93.6	0.0000	
40	39	0	43.2	93.6	0.0000	BUFFALO
41	40	0	1.0	93.6	0.0000	
42	41	0	28.7	93.6	0.0000	
43	42	0	28.9	93.6	0.0000	
44	43	0	2.7	93.6	0.415	HORSE
45	44	0	0.6	93.796	0.219	FT McM STP
46	45	0	30.4	94.015	51.54	CLEARWATER
47	46	0	2.1	145.266	0.289	SUNCOR

48	47	0	15.8	145.555	0.318	STEEPBANK
49	48	0	3.9	145.873	0.707	MUSKEG
50	49	0	17.4	146.58	0.210	MCKAY
51	50	0	65.8	146.79	0.842	ELLS
52	51	0	58.9	147.64	9.76	FIREBAG
53	0	0	8.0	27.1	0.	
54	53	0	1.0	27.1	0.	
55	54	0	24.7	27.1	0.	
56	55	0	19.8	27.1	0.	

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

STNAM	INST
WELDWOOD	2
OLDMAN CR	5
SPRING 1	6
BERLAND R	7
SPRING 2	8
MARSH HEAD CR	9
PINE CR	10
SPRING 3	12
TWO CREEK	13
WINDFALL CR	14
SAKWATAMAU R	17
McLEOD R	18
MILLAR WEST.	19
STP	21
FREEMAN R	23
PEMBINA R	26
LESSER SLAVE R	28
UNKNOWN	29
STP	30
LA BICHE R	33
CALLING R	34
PELICAN R	36
HOUSE R	37
BUFFALO R	40
HORSE R	44
STP	45
CLEARWATER R	46
SUNCOR	47
STEEPBANK R	48
MUSKEG R	49
MCKAY R	50
ELLS R	51
FIREBAG	52

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)

RNAM

ATHABASCA RIVER

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

TNAM	INTR

LESSER SLAVE

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH	XLD1	XLD2	XLD3	XLD4	XLD5	XLD6	XLD7	XLD8	XLD9
1	0	0	0	0	0	0	0	0	0
2	156.0	7.1	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	12.57	6.4	0	0	0	0	0	0
6	0	11.69	7.04	0	0	0	0	0	0
7	0	8.71	5.76	0	0	0	0	0	0
8	0	11.7	0.64	0	0	0	0	0	0
9	0	10.47	5.12	0	0	0	0	0	0
10	0	10.61	1.92	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	10.76	1.28	0	0	0	0	0	0
13	0	7.91	7.68	0	0	0	0	0	0
14	0	9.15	8.32	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
17	0	12.57	6.4	0	0	0	0	0	0
18	0	5.28	10.24	0	0	0	0	0	0
19	2520.0	7.39	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
21	12.8	4.4	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0
23	0	5.22	3.2	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0
26	0	2.75	2.88	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0
29	0	11.69	7.04	0	0	0	0	0	0
30	76.92	5.0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0
33	0	1.45	5.76	0	0	0	0	0	0
34	0	10.85	5.12	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0
36	0	12.85	19.84	0	0	0	0	0	0
37	0	10.56	5.76	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0
40	0	13.3	7.68	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0
44	0	13.3	7.68	0	0	0	0	0	0
45	108.49	5.0	0	0	0	0	0	0	0
46	0	12.35	5.76	0	0	0	0	0	0
47	24.68	5.0	0	0	0	0	0	0	0
48	0	13.44	8.32	0	0	0	0	0	0
49	0	10.75	10.88	0	0	0	0	0	0
50	0	12.24	9.6	0	0	0	0	0	0

51	0	13.03	5.76	0	0	0	0	0	0
52	0	5.76	11.2	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0

GROUP 7 (ONE LINE FOR EACH HEADWATER)

X01	X02	X03	X04	X05	X06	X07	X08	X09
0.0	11.74	6.4	0	0	0.00	0	0	0
0.0	13.28	7.04	0	0	0.000	0	0	0

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

REACH	XK1	XK2	XK3	XK4	XM1	XM2	XM3	XRES	XDS	XP
1	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
2	0.035	0.58	.15	.020	.00	.00	.000	.65	13.0	.001
3	0.035	0.001	.1	.020	.00	.00	.000	.25	13.0	.001
4	0.035	0.001	.1	.020	.00	.00	.000	.00	13.0	.001
5	0.035	0.001	.05	.020	.00	.00	.000	.00	13.0	.001
6	0.035	0.001	.05	.020	.00	.00	.000	.00	13.0	.001
7	0.035	0.001	.05	.020	.00	.00	.000	.00	13.0	.001
8	0.035	0.001	.05	.020	.00	.00	.000	.00	13.0	.001
9	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
10	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
11	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
12	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
13	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
14	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
15	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
16	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
17	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
18	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
19	0.050	1.63	1.3	.020	.00	.00	.000	.85	13.0	.001
20	0.050	0.001	1.3	.020	.00	.00	.000	.85	13.0	.001
21	0.050	0.001	1.3	.020	.00	.00	.000	.85	13.0	.001
22	0.050	0.001	.9	.020	.00	.00	.000	.25	13.0	.001
23	0.050	0.001	.6	.020	.00	.00	.000	.00	13.0	.001
24	0.050	0.001	.6	.020	.00	.00	.000	.00	13.0	.001
25	0.050	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
26	0.050	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
27	0.050	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
28	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
29	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
30	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
31	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
32	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
33	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
34	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
35	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
36	0.050	0.001	.000	.020	.00	.00	.000	.401	13.0	.001
37	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
38	0.050	0.001	.000	.020	.00	.00	4760.3	.001	13.0	.001
39	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001

40	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
41	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
42	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
43	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
44	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
45	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
46	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
47	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
48	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
49	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
50	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
51	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
52	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
53	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
54	0.050	0.001	.000	.020	.00	.00	.000	.05	13.0	.001
55	0.050	0.001	.000	.020	.00	.00	.000	.05	13.0	.001
56	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001

GROUP 9 (AVERAGE RIVER TEMPERATURE)
TEMPER
****
0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)

REACH	REFQ	T	HEXN	VEXN	RFDGR
1	50	.045	.516	.353	0.
2	50	.281	.512	.344	0.
3	50	.624	.516	.353	0.
4	50	.448	.550	.346	0.
5	50	.543	.550	.346	0.
6	50	.622	.550	.346	0.
7	50	.297	.540	.266	0.
8	50	.308	.540	.266	0.
9	50	.004	.540	.266	0.
10	50	.284	.540	.266	0.
11	50	.202	.551	.326	0.
12	50	.176	.551	.326	0.
13	50	.154	.551	.326	0.
14	50	.704	.551	.326	0.
15	50	.044	.551	.326	0.
16	50	.147	.551	.326	0.
17	50	.022	.463	.362	0.
18	50	.002	.463	.362	0.
19	50	.021	.463	.362	0.
20	50	.041	.463	.362	0.
21	50	.414	.463	.362	0.
22	50	1.940	.536	.274	0.
23	50	1.799	.523	.288	0.
24	50	1.426	.512	.350	0.
25	50	0.463	.512	.260	0.
26	50	0.805	.512	.260	0.
27	50	1.453	.512	.260	0.
28	50	1.960	.512	.260	0.
29	50	2.350	.512	.260	0.

30	50	2.009	.592	.295	0.
31	50	.038	.592	.295	0.
32	50	.280	.592	.295	0.
33	50	.587	.592	.295	0.
34	50	2.331	.592	.295	0.
35	50	1.524	.598	.335	0.
36	50	1.878	.598	.335	0.
37	50	.348	.598	.335	0.
38	50	.010	.505	.292	0.
39	50	1.077	.627	.358	0.
40	50	1.397	.627	.358	0.
41	50	.011	.632	.294	0.
42	50	1.066	.555	.257	0.
43	50	.827	.687	.252	0.
44	50	.077	.687	.252	0.
45	50	.020	.543	.136	0.
46	50	.994	.543	.136	0.
47	50	.069	.543	.136	0.
48	50	.516	.543	.136	0.
49	50	.127	.543	.136	0.
50	50	.569	.543	.136	0.
51	50	2.151	.543	.136	0.
52	50	2.901	.354	.254	0.
53	50	.180	.555	.351	0.
54	50	.023	.555	.351	0.
55	50	.557	.555	.351	0.
56	50	.471	.536	.289	0.

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)
FNAM
****
ATHA1
LSR1

UPPER ATHABASCA - FEBRUARY 1989 CALIB (C1) - JUNE 13, 1989

NRT	NTRIB	MAXTR	MAXRI	MAXPT	NSTP	NVAR
29	0	0	29	29	18	9

GROUP 2 (ONE LINE FOR EACH REACH)

IRCH	UP1	IUP2	X	Q	QLD	SOURCE NAME
1	0	0	1.7	43.0	0.000	
2	1	0	8.5	43.000	0.000	WELDWOOD <==OPEN
3	2	0	27.3	43.000	0.000	
4	3	0	18.6	43.000	0.000	
5	4	0	22.5	43.000	0.000	OLDMAN CR
6	5	0	25.8	43.000	0.000	SPRING 1
7	6	0	13.3	43.000	0.000	BERLAND R
8	7	0	13.8	43.000	0.000	SPRING 2
9	8	0	0.2	43.000	0.000	MARSH CR
10	9	0	12.7	43.000	0.000	PINE CR
11	10	0	9.2	43.000	0.000	
12	11	0	8.0	43.000	0.000	SPRING 3
13	12	0	7.0	43.000	0.000	TWO CREEK
14	13	0	32.0	43.000	0.000	WINDFALL
15	14	0	2.0	43.5	0.000	
16	15	0	6.7	43.5	0.000	
17	16	0	1.1	43.5	0.500	SAKWATAMAU
18	17	0	0.1	44.0	4.750	McLEOD R
19	18	0	1.5	48.612	0.138	MILLAR WEST.<==OPEN
20	19	0	2.1	48.75	0.000	
21	20	0	21.1	48.713	0.037	WHITE STP
22	21	0	70.0	48.75	0.000	
23	22	0	44.6	48.75	0.558	FREEMAN R.
24	23	0	31.5	49.308	0.000	
25	24	0	11.5	49.308	0.000	
26	25	0	20.0	49.308	3.000	PEMBINA R.
27	26	0	36.1	53.3	0.000	LOCAL
28	27	0	48.7	52.3	25.900	LESSER SLAVE R.
29	28	0	58.4	79.1	4.192	UNKNOWN

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

STNAM	INST
WELDWOOD	2
OLDMAN CR	5
SPRING 1	6
BERLAND R	7
SPRING 2	8
MARSH HEAD CR	9
PINE CR	10
SPRING 3	12
TWO CREEK	13
WINDFALL CR	14
SAKWATAMAU R	17
McLEOD R	18
MILLAR WEST.	19
STP	21

FREEMAN R	23
PEMBINA R	26
LESSER SLAVE	28
UNKNOWN	29

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)
RNAM
****
UPPER ATHABASCA

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)
TNAM INTR
****

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH	XLD1	XLD2	XLD3	XLD4	XLD5	XLD6	XLD7	XLD8	XLD9
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
17	0	12.57	6.4	0	0	0	0	0	0
18	0	4.88	3.2	0	0	0	0	0	0
19	2004.0	7.75	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
21	10.6	4.4	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0
23	0	5.22	12.16	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0
26	0	1.49	1.92	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0
28	0	12.19	3.84	0	0	0	0	0	0
29	0	12.57	6.4	0	0	0	0	0	0

GROUP 7 (ONE LINE FOR EACH HEADWATER)

X01	X02	X03	X04	X05	X06	X07	X08	X09
0	9.79	5.44	0	0	0	0	0	0

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

REACH	XK1	XK2	XK3	XK4	XM1	XM2	XM3	XRES	XDS	XP

1	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
2	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
3	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
4	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
5	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
6	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
7	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
8	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
9	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
10	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
11	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
12	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
13	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
14	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
15	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
16	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
17	0.001	0.001	.001	.002	.00	.00	.000	.001	13.0	.001
18	0.001	0.001	.001	.02	.00	.00	.000	.001	13.0	.001
19	0.05	1.63	.9	.02	.00	.00	.000	.85	13.0	.001
20	0.05	0.001	.9	.02	.00	.00	.000	.85	13.0	.001
21	0.05	0.001	.9	.02	.00	.00	.000	.85	13.0	.001
22	0.05	0.001	.6	.02	.00	.00	.000	.35	13.0	.001
23	0.05	0.001	.4	.02	.00	.00	.000	.00	13.0	.001
24	0.05	0.001	.4	.02	.00	.00	.000	.00	13.0	.001
25	0.05	0.001	.0	.02	.00	.00	.000	.001	13.0	.001
26	0.05	0.001	.0	.02	.00	.00	.000	.001	13.0	.001
27	0.05	0.001	.0	.02	.00	.00	.000	.001	13.0	.001
28	0.05	0.001	.0	.02	.00	.00	.000	.001	13.0	.001
29	0.05	0.001	.0	.02	.00	.00	.000	.001	13.0	.001

GROUP 9 (AVERAGE RIVER TEMPERATURE)
TEMPER
****
0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)

REACH	REFQ	T	HEXN	VEXN	RFDGR
1	50	.055	.516	.353	0.
2	50	.055	.512	.344	0.
3	50	.055	.516	.353	0.
4	50	.055	.550	.346	0.
5	50	.055	.550	.346	0.
6	50	.055	.550	.346	0.
7	50	.055	.540	.266	0.
8	50	.055	.540	.266	0.
9	50	.055	.540	.266	0.
10	50	.055	.540	.266	0.
11	50	.055	.551	.326	0.
12	50	.055	.551	.326	0.
13	50	.055	.551	.326	0.
14	50	.055	.551	.326	0.
15	50	.055	.551	.326	0.
16	50	.055	.551	.326	0.
17	50	.055	.463	.362	0.

18	50	.002	.463	.362	0.
19	50	.021	.463	.362	0.
20	50	.041	.463	.362	0.
21	50	.414	.463	.362	0.
22	50	1.940	.536	.274	0.
23	50	1.799	.523	.288	0.
24	50	1.426	.512	.350	0.
25	50	.463	.512	.260	0.
26	50	.805	.512	.260	0.
27	50	1.453	.512	.260	0.
28	50	1.960	.512	.260	0.
29	50	2.350	.512	.260	0.

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)
FNAM
****
ATHA2

ATHABASCA - SURVEY 3,1989 CALIBRATION <== JUNE 13, 1989

NRT	NTRIB	MAXTR	MAXRI	MAXPT	NSTP	NVAR
56	1	4	52	52	33	9

GROUP 2 (ONE LINE FOR EACH REACH)

IRCH	UP1	IUP2	X	Q	QLD	SOURCE NAME
1	0	0	1.7	31.3	0.000	
2	1	0	12.2	30.28	1.020	WELDWOOD <==OPEN
3	2	0	23.6	31.3	0.000	
4	3	0	18.6	31.3	0.000	
5	4	0	22.5	31.3	0.950	OLDMAN CR
6	5	0	25.8	32.25	1.230	SPRING 1
7	6	0	13.3	33.48	5.520	BERLAND R
8	7	0	13.8	39.0	0.490	SPRING 2
9	8	0	0.2	39.49	0.173	MARSH CR
10	9	0	12.7	39.663	0.310	PINE CR
11	10	0	9.2	39.973	0.000	
12	11	0	8.0	39.973	0.490	SPRING 3
13	12	0	7.0	40.463	0.014	TWO CREEK
14	13	0	32.0	40.477	0.503	WINDFALL
15	14	0	2.0	40.98	0.000	
16	15	0	6.7	40.98	0.000	
17	16	0	1.1	40.98	0.490	SAKWATAMAU
18	17	0	0.1	41.47	4.630	McLEOD R
19	18	0	1.5	45.976	0.124	MILLAR WEST.<==OPEN
20	19	0	2.1	46.10	0.000	
21	20	0	21.1	46.065	0.035	WHITE STP
22	21	0	70.0	46.10	0.000	
23	22	0	44.6	46.10	0.590	FREEMAN R.
24	23	0	31.5	46.69	0.000	
25	24	0	11.5	46.69	0.0000	
26	25	0	20.0	46.69	2.91	PEMBINA
27	26	0	36.1	59.6	0.0000	
28	27	56	48.7	72.3	0.0000	LESSER SLAVE
29	28	0	58.4	72.3	3.0	UNKNOWN
30	29	0	53.0	75.288	0.012	ATHAB STP
31	30	0	1.0	75.3	0.0000	
32	31	0	7.4	75.3	0.0000	
33	32	0	15.5	75.3	0.426	LA BICHE
34	33	0	61.5	75.726	0.022	CALLING
35	34	0	47.3	75.748	0.0000	
36	35	0	58.3	75.748	0.154	PELICAN
37	36	0	10.8	75.902	0.272	MOUSE
38	37	0	1.0	76.174	0.0000	
39	38	0	33.3	76.174	0.0000	
40	39	0	43.2	76.174	0.014	BUFFALO
41	40	0	1.0	76.188	0.0000	
42	41	0	28.7	76.188	0.0000	
43	42	0	28.9	76.188	0.0000	
44	43	0	2.7	76.188	0.390	HORSE
45	44	0	0.6	76.49	0.088	FT McM STP
46	45	0	30.4	76.578	46.3	CLEARWATER
47	46	0	2.1	122.637	0.241	SUNCOR

48	47	0	15.8	122.878	0.274	STEEPBANK
49	48	0	3.9	123.152	0.501	MUSKEG
50	49	0	17.4	123.653	0.625	MCKAY
51	50	0	65.8	124.278	0.670	ELLS
52	51	0	58.9	124.948	6.73	FIREBAG
53	0	0	8.0	22.7	0.	
54	53	0	1.0	22.7	0.	
55	54	0	24.7	22.7	0.	
56	55	0	19.8	22.7	0.	

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

STNAM	INST
WELDWOOD	2
OLDMAN CR	5
SPRING 1	6
BERLAND R	7
SPRING 2	8
MARSH HEAD CR	9
PINE CR	10
SPRING 3	12
TWO CREEK	13
WINDFALL CR	14
SAKWATAMAU R	17
McLEOD R	18
MILLAR WEST.	19
STP	21
FREEMAN R	23
PEMBINA R	26
LESSER SLAVE R	28
UNKNOWN	29
STP	30
LA BICHE R	33
CALLING R	34
PELICAN R	36
HOUSE R	37
BUFFALO R	40
HORSE R	44
STP	45
CLEARWATER R	46
SUNCOR	47
STEEPBANK R	48
MUSKEG R	49
MCKAY R	50
ELLS R	51
FIREBAG	52

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)

RNAM

ATHABASCA RIVER

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

TNAM	INTR

LESSER SLAVE

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH	XLD1	XLD2	XLD3	XLD4	XLD5	XLD6	XLD7	XLD8	XLD9
1	0	0	0	0	0	0	0	0	0
2	104.5	7.09	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	12.82	4.48	0	0	0	0	0	0
6	0	11.55	6.4	0	0	0	0	0	0
7	0	9.53	6.4	0	0	0	0	0	0
8	0	12.07	4.48	0	0	0	0	0	0
9	0	11.66	4.48	0	0	0	0	0	0
10	0	12.16	3.2	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	11.42	3.84	0	0	0	0	0	0
13	0	10.45	4.48	0	0	0	0	0	0
14	0	10.92	2.56	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
17	0	12.82	4.48	0	0	0	0	0	0
18	0	5.76	5.12	0	0	0	0	0	0
19	2228.0	7.39	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
21	10.6	4.4	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0
23	0	9.6	7.68	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0
26	0	1.46	8.96	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0
29	0	12.82	4.48	0	0	0	0	0	0
30	30.6	5.0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0
33	0	3.24	13.44	0	0	0	0	0	0
34	0	11.45	3.84	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0
36	0	13.01	10.24	0	0	0	0	0	0
37	0	9.08	3.84	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0
40	0	13.15	4.48	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0
44	0	12.95	2.56	0	0	0	0	0	0
45	142.30	5.0	0	0	0	0	0	0	0
46	0	12.52	2.24	0	0	0	0	0	0
47	3.8	5.0	0	0	0	0	0	0	0
48	0	13.09	5.12	0	0	0	0	0	0
49	0	5.95	3.84	0	0	0	0	0	0
50	0	11.95	5.12	0	0	0	0	0	0

51	0	12.41	3.84	0	0	0	0	0	0
52	0	5.25	5.12	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0

GROUP 7 (ONE LINE FOR EACH HEADWATER)

X01	X02	X03	X04	X05	X06	X07	X08	X09
0.0	11.14	6.4	0	0	0	0	0	0
0.0	12.94	2.56	0	0	0	0	0	0

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

REACH	XK1	XK2	XK3	XK4	XM1	XM2	XM3	XRES	XDS	XP
1	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
2	0.035	0.58	.15	.020	.00	.00	.000	.65	13.0	.001
3	0.035	0.001	.1	.020	.00	.00	.000	.55	13.0	.001
4	0.035	0.001	.1	.020	.00	.00	.000	.35	13.0	.001
5	0.035	0.001	.05	.020	.00	.00	.000	.10	13.0	.001
6	0.035	0.001	.05	.020	.00	.00	.000	.07	13.0	.001
7	0.035	0.001	.05	.020	.00	.00	.000	.07	13.0	.001
8	0.035	0.001	.05	.020	.00	.00	.000	.07	13.0	.001
9	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
10	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
11	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
12	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
13	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
14	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
15	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
16	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
17	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
18	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
19	0.050	1.63	.7	.020	.00	.00	.000	.85	13.0	.001
20	0.050	0.001	.7	.020	.00	.00	.000	.85	13.0	.001
21	0.050	0.001	.7	.020	.00	.00	.000	.85	13.0	.001
22	0.050	0.001	.4	.020	.00	.00	.000	.55	13.0	.001
23	0.050	0.001	.3	.020	.00	.00	.000	.01	13.0	.001
24	0.050	0.001	.3	.020	.00	.00	.000	.01	13.0	.001
25	0.050	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
26	0.050	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
27	0.050	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
28	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
29	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
30	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
31	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
32	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
33	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
34	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
35	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
36	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
37	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
38	0.050	0.001	.000	.020	.00	.00	3461.2	.001	13.0	.001
39	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001

40	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
41	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
42	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
43	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
44	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
45	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
46	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
47	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
48	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
49	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
50	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
51	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
52	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
53	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
54	0.050	0.001	.000	.020	.00	.00	.000	.05	13.0	.001
55	0.050	0.001	.000	.020	.00	.00	.000	.05	13.0	.001
56	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001

GROUP 9 (AVERAGE RIVER TEMPERATURE)

TEMPER

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0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)

REACH	REFQ	T	HEXN	VEXN	RFDGR
**********					
1	50	.045	.516	.353	0.
2	50	.281	.512	.344	0.
3	50	.624	.516	.353	0.
4	50	.448	.550	.346	0.
5	50	.543	.550	.346	0.
6	50	.622	.550	.346	0.
7	50	.297	.540	.266	0.
8	50	.308	.540	.266	0.
9	50	.004	.540	.266	0.
10	50	.284	.540	.266	0.
11	50	.202	.551	.326	0.
12	50	.176	.551	.326	0.
13	50	.154	.551	.326	0.
14	50	.704	.551	.326	0.
15	50	.044	.551	.326	0.
16	50	.147	.551	.326	0.
17	50	.022	.463	.362	0.
18	50	.002	.463	.362	0.
19	50	.021	.463	.362	0.
20	50	.041	.463	.362	0.
21	50	.414	.463	.362	0.
22	50	1.940	.536	.274	0.
23	50	1.799	.523	.288	0.
24	50	1.426	.512	.350	0.
25	50	0.463	.512	.260	0.
26	50	0.805	.512	.260	0.
27	50	1.453	.512	.260	0.
28	50	1.960	.512	.260	0.
29	50	2.350	.512	.260	0.

30	50	2.009	.592	.295	0.
31	50	.038	.592	.295	0.
32	50	.280	.592	.295	0.
33	50	.587	.592	.295	0.
34	50	2.331	.592	.295	0.
35	50	1.524	.598	.335	0.
36	50	1.878	.598	.335	0.
37	50	.348	.598	.335	0.
38	50	.010	.505	.292	0.
39	50	1.077	.627	.358	0.
40	50	1.397	.627	.358	0.
41	50	.011	.632	.294	0.
42	50	1.066	.555	.257	0.
43	50	.827	.687	.252	0.
44	50	.077	.687	.252	0.
45	50	.020	.543	.136	0.
46	50	.994	.543	.136	0.
47	50	.069	.543	.136	0.
48	50	.516	.543	.136	0.
49	50	.127	.543	.136	0.
50	50	.569	.543	.136	0.
51	50	2.151	.543	.136	0.
52	50	2.901	.354	.254	0.
53	50	.180	.555	.351	0.
54	50	.023	.555	.351	0.
55	50	.557	.555	.351	0.
56	50	.471	.536	.289	0.

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)
FNAM
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ATHA3
LSR3

APPENDIX 2.2 - MAINSTEM RIVER OBSERVED FILES

Column Description

Column #1 - River kilometer from Hinton for Athabasca River files and from Slave Lake for Lesser Slave River files

Column #2 - Mean minus one standard deviation

Column #3 - Mean

Column #4 - Mean plus one standard deviation

Filename	Description
UD0288DO.OBS	February 1988 - D.O. - Athabasca River
UD0288BO.OBS	February 1988 - BOD_5 - Athabasca River
UD0388DO.OBS	March 1988 - D.O. - Athabasca River
UD0388BO.OBS	March 1988 - BOD_5 - Athabasca River
0189DO.OBS	Survey #1 1989 - D.O. - Athabasca River
LS0189DO.OBS	Survey #1 1989 - D.O. - Lesser Slave River
0189BO.OBS	Survey #1 1989 - BOD_5 - Athabasca River
LS0189BO.OBS	Survey #1 1989 - BOD_5 - Lesser Slave River
UD0289DO.OBS	Survey #2 1989 - D.O. - Athabasca River
UD0289BO.OBS	Survey #2 1989 - BOD_5 - Athabasca River
0389DO.OBS	Survey #3 1989 - D.O. - Athabasca River
LS0389DO.OBS	Survey #3 1989 - D.O. - Lesser Slave River
0389BO.OBS	Survey #3 1989 - BOD_5 - Athabasca River
LS0389BO.OBS	Survey #3 1989 - BOD_5 - Lesser Slave River

4.2	10.81410	10.95	11.08589
9.1	11.41	11.41	11.41
14.9	11.2	11.25	11.3
23.9	10.35684	10.67666	10.99649
40.9	9.446601	9.87	10.29339
64.2	9.32	9.575	9.83
103.5	9.225512	9.596666	9.967821
160.7	9.81	9.81	9.81
207.9	9.288191	9.75	10.21180
212.9	8.798160	9.046666	9.295173
220.4	8.823350	9.456666	10.08998
233.5	8.744147	8.873333	9.002518
301.3	8.409729	9.046666	9.683603
433	7.991775	8.31	8.628224
506.9	8.982351	9.13	9.277648
552.6	8.647099	8.736666	8.826233

4.2	8.589683	9.133333	9.676983
9.1	6.8	7.2	7.6
14.9	6.5	7.1	7.7
23.9	3.001516	3.733333	4.465149
40.9	3.297631	3.533333	3.769035
64.2	3.3	3.3	3.3
103.5	1.575735	2	2.424264
160.7	0.799999	0.8	0.800000
207.9	1.230309	1.966666	2.703024
233.5	1.287395	1.866666	2.445938
301.3	1.822372	2.233333	2.644294
433	1.503350	1.833333	2.163316
506.9	2.865153	3.6	4.334846

4.2	11.44509	11.58	11.71490
9.1	10.96	11.105	11.25
14.9	10.32914	10.78	11.23085
23.9	10.15	10.655	11.16
40.9	10.71428	11.00666	11.29905
64.2	10.2	10.325	10.45
103.5	9.74	9.92	10.1
160.7	9.72	10.035	10.35
207.9	9.64	9.69	9.74
212.9	9.329961	9.473333	9.616705
301.3	9.610972	9.673333	9.735694
433	8.999526	9.046666	9.093807
506.9	9.068162	9.45	9.831837
552.6	9.391675	9.556666	9.721658

4.2	2.354061	2.933333	3.512604
9.1	2.261186	2.466666	2.672147
14.9	2.336700	2.5	2.663299
23.9	2.6	2.65	2.7
40.9	2.258578	2.4	2.541421
64.2	1.899999	1.9	1.900000
103.5	1.641944	1.766666	1.891388
160.7	2.399999	2.4	2.400000
207.9	1.961186	2.166666	2.372147
233.5	1.196699	1.366666	1.536633
301.3	1.105607	1.4	1.694392
433	0.858578	1	1.141421
506.9	1.393398	1.733333	2.073267

2.7	11.41835	11.5	11.58164
7.7	11.22253	11.39666	11.57079
11.6	10.94411	11.185	11.42588
22.65	10.91103	11.055	11.19896
38.75	10.72142	10.90333	11.08523
62.3	10.75047	11.0025	11.25452
104.2	10.37212	10.8975	11.42287
163.1	10.28515	10.4075	10.52984
209.4	10.25477	10.53	10.80522
213.7	9.720244	9.925	10.12975
220.7	8.676417	9.055	9.433582
235.8	8.693586	8.8225	8.951413
270.65	8.509501	8.5725	8.635498
305.7	7.554532	7.635	7.715467
392.6	7.987213	8.1075	8.227786
450.1	7.467725	7.5925	7.717274
516.8	8.685731	8.805	8.924268
557.2	8.736412	8.8375	8.938587
618.2	8.07	8.16	8.25
678.2	8.02	8.11	8.19
741.2	8.10	8.30	8.50
800.7	7.17	7.36	7.54
808.4	7.12	7.42	7.72
845.7	12.16	12.31	12.46
888.3	11.89	11.95	12.00
946.6	11.97	12.21	12.45
979.0	11.82	11.99	12.16
1029.8	11.75	11.84	11.92
1072.8	11.42	11.51	11.61
1147.6	10.28	10.44	10.59

0.00	13.22	13.38	13.54
28.00	12.83	13.19	13.55
53.50	12.21	12.34	12.47

2.7	2.1	2.1	2.1
7.7	1.7	2	2.3
11.6	1.5	1.65	1.8
22.65	1.5	2	2.5
38.75	1.2	1.3	1.4
62.3	1.299999	1.3	1.300000
104.2	1.161186	1.366666	1.572147
163.1	1.299999	1.3	1.300000
209.4	1.208611	1.333333	1.458055
213.7	6.5	6.55	6.6
220.7	2.5	2.9	3.3
235.8	1.4	1.6	1.8
270.65	1.2	1.25	1.3
305.7	0.9	0.95	1
392.6	0.6	0.7	0.8
450.1	0.736700	0.9	1.063299
516.8	1.336683	1.666666	1.996649
557.2	0.593398	0.933333	1.273267
618.2	0.80	0.80	0.80
678.2	0.60	0.70	0.80
741.2	0.50	0.70	0.90
800.7	0.80	0.80	0.80
888.3	0.35	0.50	0.65
946.6	0.52	0.57	0.61
977.1	1.60	1.60	1.60
1029.8	1.00	1.20	1.40
1072.8	1.20	1.30	1.40
1147.6	0.28	0.53	0.78

0.00	1.10	1.10	1.10
28.00	0.80	0.80	0.80
53.50	0.90	0.90	0.90

209.4	9.376664	9.7925	10.20833
213.7	8.794500	9.42	10.04549
220.7	8.594613	9.2575	9.920386
235.8	8.195905	8.6025	9.009094
270.65	7.644793	8.0375	8.430206
305.7	7.859932	7.9525	8.045067
392.6	7.104247	7.52	7.935752
450.1	6.566351	7.0975	7.628648
516.8	7.764957	7.9125	8.060042
557.2	7.199643	7.27	7.340356

209.4	0.7	0.85	1
213.7	2	2.05	2.1
220.7	1.9	2	2.1
235.8	1.9	1.95	2
270.65	1.299999	1.3	1.300000
305.7	1.6	1.65	1.7
392.6	0.3	0.45	0.6
450.1	0.117222	0.366666	0.616110
516.8	0.2	0.5	0.8
557.2	0.2	0.4	0.6

2.7	10.92	10.96	11
7.7	11.01006	11.17666	11.34326
11.6	10.93406	11.01666	11.09926
22.65	10.54124	10.64333	10.74542
38.75	10.04705	10.21	10.37294
62.3	9.886218	10.06	10.23378
104.2	9.657004	9.8275	9.997995
163.1	9.402724	9.75	10.09727
209.4	9.356285	9.4675	9.578714
213.7	9.298364	9.343333	9.388302
220.7	8.732779	8.813333	8.893886
235.8	8.026649	8.343333	8.660017
270.65	7.265798	7.375	7.484201
305.7	6.884502	6.94	6.995497
392.6	6.259223	6.3325	6.405771
450.1	5.544712	5.8275	6.110287
516.8	7.639750	7.74	7.840249
557.2	7.832016	7.955	8.077983
618.2	7.36	7.48	7.61
678.7	7.58	7.70	7.82
741.2	6.94	7.02	7.10
800.7	7.10	7.13	7.16
845.7	11.36	11.54	11.72
888.3	11.25	11.47	11.68
979.0	11.80	12.02	12.24
1029.8	11.50	11.54	11.59
1072.8	10.67	10.80	10.92
1147.6	9.76	10.10	10.45

0.00	12.69	12.94	13.20
28.00	12.61	12.85	13.10
53.50	12.02	12.14	12.26

2.7	0.4	0.4	0.4
7.7	0.216975	0.666666	1.116357
11.6	0.1	0.3	0.5
22.65	0.4	0.45	0.5
38.75	0.7	0.9	1.1
62.3	1.2	1.2	1.2
104.2	1.019526	1.066666	1.113807
163.1	0.4	0.4	0.4
209.4	0.35	0.47	0.59
213.7	2.23	2.45	2.66
220.7	1.75	2.25	2.75
235.8	1.72	2.1	2.38
270.65	3.1	3.15	3.2
305.7	1.5	1.55	1.6
392.6	1.7	1.7	1.7
450.1	1.718350	1.8	1.881649
516.8	0.2	0.2	0.2
557.2	0.418350	0.5	0.581649
618.2	0.30	0.40	0.50
678.7	0.20	0.50	0.80
741.2	0.30	0.45	0.60
800.7	0.42	0.60	0.78
888.3	0.40	0.75	1.10
946.6	0.42	0.50	0.58
979.0	0.40	0.50	0.60
1029.8	0.50	0.50	0.50
1072.8	1.20	1.30	1.40
1157.6	0.49	1.03	1.58

0.00	0.4	0.4	0.4
28.00	0.1	0.1	0.1
53.50	0.4	0.4	0.4

APPENDIX 3 - SCENARIO EVALUATION INPUT FILES FOR ATHABASCA 7Q10 FLOWS

Filename	Scenario Description
SND10.DIN	Case #1
SND11.DIN	Case #2
SND12.DIN	Case #3
SND13.DIN	Case #4
SND14.DIN	Case #5
SND15.DIN	Case #6

ATHABASCA - SCENARIO D10 <== JUNE 13, 1989

NRT	NTRIB	MAXTR	MAXRI	MAXPT	NSTP	NVAR
56	1	4	52	52	6	9

GROUP 2 (ONE LINE FOR EACH REACH)

IRCH	UP1	IUP2	X	Q	QLD	SOURCE NAME
1	0	0	1.7	27.1	0.000	
2	1	0	12.2	26.129	0.974	WELDWOOD <==OPEN
3	2	0	23.6	27.1	0.000	
4	3	0	18.6	27.1	0.000	
5	4	0	22.5	27.1	2.3	LOCAL
6	5	0	25.8	29.4	0.000	
7	6	0	13.3	29.4	5.2	BERLAND R
8	7	0	13.8	34.6	1.3	LOCAL
9	8	0	0.2	35.9	0.000	
10	9	0	12.7	35.9	5.0	LOCAL
11	10	0	9.2	40.9	0.000	
12	11	0	8.0	40.9	0.000	
13	12	0	7.0	40.9	0.000	
14	13	0	32.0	40.9	0.000	
15	14	0	2.0	40.9	0.000	A.N.C <===OPEN
16	15	0	6.7	40.9	0.000	
17	16	0	1.1	40.9	0.000	
18	17	0	0.1	40.9	2.3	McLEOD R
19	18	0	1.5	43.2	0.000	MILLAR WEST.<==OPEN
20	19	0	2.1	43.2	0.1	LOCAL
21	20	0	21.1	43.265	0.035	WHITE STP
22	21	0	70.0	43.3	0.000	
23	22	0	44.6	43.3	0.1	FREEMAN R.
24	23	0	31.5	43.4	0.2	LOCAL
25	24	0	11.5	43.6	0.0000	
26	25	0	20.0	43.6	1.80	PEMBINA
27	26	0	36.1	45.4	0.3	LOCAL
28	27	56	48.7	53.2	0.0000	LESSER SLAVE
29	28	0	58.4	53.2	0.1	LOCAL
30	29	0	53.0	53.288	0.012	STP
31	30	0	1.0	53.3	0.00	ALPAC <===OPEN
32	31	0	7.4	53.3	0.0000	
33	32	0	15.5	53.3	2.5	LA BICHE
34	33	0	61.5	55.8	2.5	CALLING
35	34	0	47.3	58.3	0.0000	
36	35	0	58.3	58.3	2.5	PELICAN
37	36	0	10.8	60.8	0.3	HOUSE
38	37	0	1.0	61.1	0.0000	
39	38	0	33.3	61.1	0.0000	
40	39	0	43.2	61.1	1.45	BUFFALO
41	40	0	1.0	62.55	0.0000	
42	41	0	28.7	62.55	0.0000	
43	42	0	28.9	62.55	0.0000	
44	43	0	2.7	62.55	1.45	HORSE
45	44	0	0.6	63.912	0.088	STP
46	45	0	30.4	64.0	45.2	CLEARWATER
47	46	0	2.1	108.959	0.241	SUNCOR

48	47	0	15.8	109.2	0.8	STEEPBANK
49	48	0	3.9	110.0	0.4	MUSKEG
50	49	0	17.4	110.4	0.6	MCKAY
51	50	0	65.8	111.0	2.5	ELLS
52	51	0	58.9	113.5	7.3	FIREBAG
53	0	0	8.0	7.5	0.	
54	53	0	1.0	7.5	0.	AEC <===OPEN
55	54	0	24.7	7.5	0.	
56	55	0	19.8	7.5	0.	

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

STNAM	INST
WELDWOOD	2
A.N.C.	15
MILLAR WESTERN	19
LESSER SLAVE R.	28
ALPAC	31
GRAND RAPIDS	38

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)

RNAM

ATHABASCA RIVER

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

TNAM	INTR
LESSER SLAVE	

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH	XLD1	XLD2	XLD3	XLD4	XLD5	XLD6	XLD7	XLD8	XLD9
1	0	0	0	0	0	0	0	0	0
2	175.2	7.09	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	11.55	6.4	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	9.53	6.4	0	0	0	0	0	0
8	0	11.55	6.4	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	11.55	6.4	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0
18	0	5.76	5.12	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0
20	0	11.55	6.4	0	0	0	0	0	0
21	10.6	4.4	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0

23	0	9.6	7.68	0	0	0	0	0	0
24	0	11.55	6.4	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0
26	0	1.46	8.96	0	0	0	0	0	0
27	0	11.55	6.4	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0
29	0	11.55	6.4	0	0	0	0	0	0
30	30.6	5.0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0
33	0	3.24	13.44	0	0	0	0	0	0
34	0	11.45	3.84	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0
36	0	13.01	10.24	0	0	0	0	0	0
37	0	9.08	3.84	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0
40	0	13.15	4.48	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0
44	0	12.95	2.56	0	0	0	0	0	0
45	142.30	5.0	0	0	0	0	0	0	0
46	0	12.52	2.24	0	0	0	0	0	0
47	3.8	5.0	0	0	0	0	0	0	0
48	0	13.09	5.12	0	0	0	0	0	0
49	0	5.95	3.84	0	0	0	0	0	0
50	0	11.95	5.12	0	0	0	0	0	0
51	0	12.41	3.84	0	0	0	0	0	0
52	0	5.25	5.12	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0

GROUP 7 (ONE LINE FOR EACH HEADWATER)

X01	X02	X03	X04	X05	X06	X07	X08	X09
0.0	11.14	6.4	0	0	0	0	0	0
0.0	12.94	2.56	0	0	0	0	0	0

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

REACH	XK1	XK2	XK3	XK4	XM1	XM2	XM3	XRES	XDS	XP
1	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
2	0.035	0.58	.15	.020	.00	.00	.000	.65	13.0	.001
3	0.035	0.001	.1	.020	.00	.00	.000	.55	13.0	.001
4	0.035	0.001	.1	.020	.00	.00	.000	.35	13.0	.001
5	0.035	0.001	.05	.020	.00	.00	.000	.10	13.0	.001
6	0.035	0.001	.05	.020	.00	.00	.000	.07	13.0	.001
7	0.035	0.001	.05	.020	.00	.00	.000	.07	13.0	.001
8	0.035	0.001	.05	.020	.00	.00	.000	.07	13.0	.001
9	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
10	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
11	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001

12	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
13	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
14	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
15	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
16	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
17	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
18	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
19	0.035	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
20	0.035	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
21	0.035	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
22	0.035	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
23	0.035	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
24	0.035	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
25	0.035	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
26	0.035	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
27	0.035	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
28	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
29	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
30	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
31	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
32	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
33	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
34	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
35	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
36	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
37	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
38	0.035	0.001	.000	.020	.00	.00	2602.57	.001	13.0	.001
39	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
40	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
41	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
42	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
43	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
44	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
45	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
46	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
47	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
48	0.035	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
49	0.035	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
50	0.035	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
51	0.035	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
52	0.035	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
53	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
54	0.035	0.001	.000	.020	.00	.00	.000	.05	13.0	.001
55	0.035	0.001	.000	.020	.00	.00	.000	.05	13.0	.001
56	0.035	0.001	.000	.020	.00	.00	.000	.15	13.0	.001

GROUP 9 (AVERAGE RIVER TEMPERATURE)
TEMPER
****
0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)

REACH	REFQ	T	HEXN	VEXN	RFDGR
**********					
1	50	.045	.516	.353	0.

2	50	.281	.512	.344	0.
3	50	.624	.516	.353	0.
4	50	.448	.550	.346	0.
5	50	.543	.550	.346	0.
6	50	.622	.550	.346	0.
7	50	.297	.540	.266	0.
8	50	.308	.540	.266	0.
9	50	.004	.540	.266	0.
10	50	.284	.540	.266	0.
11	50	.202	.551	.326	0.
12	50	.176	.551	.326	0.
13	50	.154	.551	.326	0.
14	50	.704	.551	.326	0.
15	50	.044	.551	.326	0.
16	50	.147	.551	.326	0.
17	50	.022	.463	.362	0.
18	50	.002	.463	.362	0.
19	50	.029	.463	.362	0.
20	50	.041	.463	.362	0.
21	50	.414	.463	.362	0.
22	50	1.940	.536	.274	0.
23	50	1.799	.523	.288	0.
24	50	1.426	.512	.350	0.
25	50	0.463	.512	.260	0.
26	50	0.805	.512	.260	0.
27	50	1.453	.512	.260	0.
28	50	1.960	.512	.260	0.
29	50	2.350	.512	.260	0.
30	50	2.009	.592	.295	0.
31	50	.038	.592	.295	0.
32	50	.280	.592	.295	0.
33	50	.587	.592	.295	0.
34	50	2.331	.592	.295	0.
35	50	1.524	.598	.335	0.
36	50	1.878	.598	.335	0.
37	50	.348	.598	.335	0.
38	50	.010	.505	.292	0.
39	50	1.077	.627	.358	0.
40	50	1.397	.627	.358	0.
41	50	.011	.632	.294	0.
42	50	1.066	.555	.257	0.
43	50	.827	.687	.252	0.
44	50	.077	.687	.252	0.
45	50	.020	.543	.136	0.
46	50	.994	.543	.136	0.
47	50	.069	.543	.136	0.
48	50	.516	.543	.136	0.
49	50	.127	.543	.136	0.
50	50	.569	.543	.136	0.
51	50	2.151	.543	.136	0.
52	50	2.901	.354	.254	0.
53	50	.180	.555	.351	0.
54	50	.023	.555	.351	0.
55	50	.557	.555	.351	0.
56	50	.471	.536	.289	0.

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)
FNAM
****
ATHA.D10
LSR.D10

ATHABASCA - SCENARIO D11 <== JUNE 13, 1989

NRT	NTRIB	MAXTR	MAXRI	MAXPT	NSTP	NVAR
56	1	4	52	52	33	9

GROUP 2 (ONE LINE FOR EACH REACH)

IRCH	UP1	IUP2	X	Q	QLD	SOURCE NAME
1	0	0	1.7	27.1	0.000	
2	1	0	12.2	26.08	1.020	WELDWOOD <==OPEN
3	2	0	23.6	27.1	0.000	
4	3	0	18.6	27.1	0.000	
5	4	0	22.5	27.1	2.3	LOCAL
6	5	0	25.8	29.4	0.000	
7	6	0	13.3	29.4	5.2	BERLAND R
8	7	0	13.8	34.6	1.3	LOCAL
9	8	0	0.2	35.9	0.000	
10	9	0	12.7	35.9	5.0	LOCAL
11	10	0	9.2	40.9	0.000	
12	11	0	8.0	40.9	0.000	
13	12	0	7.0	40.9	0.000	
14	13	0	32.0	40.9	0.000	
15	14	0	2.0	40.9	0.000	A.N.C <===OPEN
16	15	0	6.7	40.9	0.000	
17	16	0	1.1	40.9	0.000	
18	17	0	0.1	40.9	2.3	McLEOD R
19	18	0	1.5	43.076	0.124	MILLAR WEST.<==OPEN
20	19	0	2.1	43.2	0.1	LOCAL
21	20	0	21.1	43.265	0.035	WHITE STP
22	21	0	70.0	43.3	0.000	
23	22	0	44.6	43.3	0.1	FREEMAN R.
24	23	0	31.5	43.4	0.2	LOCAL
25	24	0	11.5	43.6	0.0000	
26	25	0	20.0	43.6	1.80	PEMBINA
27	26	0	36.1	45.4	0.3	LOCAL
28	27	56	48.7	53.2	0.0000	LESSER SLAVE
29	28	0	58.4	53.2	0.1	LOCAL
30	29	0	53.0	53.288	0.012	STP
31	30	0	1.0	53.3	0.00	ALPAC <===OPEN
32	31	0	7.4	53.3	0.0000	
33	32	0	15.5	53.3	2.5	LA BICHE
34	33	0	61.5	55.8	2.5	CALLING
35	34	0	47.3	58.3	0.0000	
36	35	0	58.3	58.3	2.5	PELICAN
37	36	0	10.8	60.8	0.3	HOUSE
38	37	0	1.0	61.1	0.0000	
39	38	0	33.3	61.1	0.0000	
40	39	0	43.2	61.1	1.45	BUFFALO
41	40	0	1.0	62.55	0.0000	
42	41	0	28.7	62.55	0.0000	
43	42	0	28.9	62.55	0.0000	
44	43	0	2.7	62.55	1.45	HORSE
45	44	0	0.6	63.912	0.088	STP
46	45	0	30.4	64.0	45.2	CLEARWATER
47	46	0	2.1	108.959	0.241	SUNCOR

48	47	0	15.8	109.2	0.8	STEEPBANK
49	48	0	3.9	110.0	0.4	MUSKEG
50	49	0	17.4	110.4	0.6	MCKAY
51	50	0	65.8	111.0	2.5	ELLS
52	51	0	58.9	113.5	7.3	FIREBAG
53	0	0	8.0	7.5	0.	
54	53	0	1.0	7.5	0.	AEC <===OPEN
55	54	0	24.7	7.5	0.	
56	55	0	19.8	7.5	0.	

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

STNAM	INST
WELDWOOD	2
OLDMAN CR	5
SPRING 1	6
BERLAND R	7
SPRING 2	8
MARSH HEAD CR	9
PINE CR	10
SPRING 3	12
TWO CREEK	13
WINDFALL CR	14
SAKWATAMAU R	17
McLEOD R	18
MILLAR WEST.	19
STP	21
FREEMAN R	23
PEMBINA R	26
LESSER SLAVE R	28
UNKNOWN	29
STP	30
LA BICHE R	33
CALLING R	34
PELICAN R	36
HOUSE R	37
BUFFALO R	40
HORSE R	44
STP	45
CLEARWATER R	46
SUNCOR	47
STEEPBANK R	48
MUSKEG R	49
MCKAY R	50
ELLS R	51
FIREBAG	52

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)

RNAM

ATHABASCA RIVER

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

TNAM	INTR

LESSER SLAVE

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH	XLD1	XLD2	XLD3	XLD4	XLD5	XLD6	XLD7	XLD8	XLD9
1	0	0	0	0	0	0	0	0	0
2	104.5	7.09	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	11.55	6.4	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0
7	0	9.53	6.4	0	0	0	0	0	0
8	0	11.55	6.4	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
10	0	11.55	6.4	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0
18	0	5.76	5.12	0	0	0	0	0	0
19	2228.0	7.39	0	0	0	0	0	0	0
20	0	11.55	6.4	0	0	0	0	0	0
21	10.6	4.4	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0
23	0	9.6	7.68	0	0	0	0	0	0
24	0	11.55	6.4	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0
26	0	1.46	8.96	0	0	0	0	0	0
27	0	11.55	6.4	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0
29	0	11.55	6.4	0	0	0	0	0	0
30	30.6	5.0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0
33	0	3.24	13.44	0	0	0	0	0	0
34	0	11.45	3.84	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0
36	0	13.01	10.24	0	0	0	0	0	0
37	0	9.08	3.84	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0
40	0	13.15	4.48	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0
44	0	12.95	2.56	0	0	0	0	0	0
45	142.30	5.0	0	0	0	0	0	0	0
46	0	12.52	2.24	0	0	0	0	0	0
47	3.8	5.0	0	0	0	0	0	0	0
48	0	13.09	5.12	0	0	0	0	0	0
49	0	5.95	3.84	0	0	0	0	0	0
50	0	11.95	5.12	0	0	0	0	0	0

51	0	12.41	3.84	0	0	0	0	0	0
52	0	5.25	5.12	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0

GROUP 7 (ONE LINE FOR EACH HEADWATER)

X01	X02	X03	X04	X05	X06	X07	X08	X09
0.0	11.14	6.4	0	.05	2.94	0	0	0
0.0	12.94	2.56	0	.31	0.000	0	0	0

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

REACH	XK1	XK2	XK3	XK4	XM1	XM2	XM3	XRES	XDS	XP
1	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
2	0.035	0.58	.15	.020	.00	.00	.000	.65	13.0	.001
3	0.035	0.001	.1	.020	.00	.00	.000	.55	13.0	.001
4	0.035	0.001	.1	.020	.00	.00	.000	.35	13.0	.001
5	0.035	0.001	.05	.020	.00	.00	.000	.10	13.0	.001
6	0.035	0.001	.05	.020	.00	.00	.000	.07	13.0	.001
7	0.035	0.001	.05	.020	.00	.00	.000	.07	13.0	.001
8	0.035	0.001	.05	.020	.00	.00	.000	.07	13.0	.001
9	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
10	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
11	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
12	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
13	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
14	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
15	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
16	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
17	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
18	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
19	0.050	1.63	.7	.020	.00	.00	.000	.85	13.0	.001
20	0.050	0.001	.7	.020	.00	.00	.000	.85	13.0	.001
21	0.050	0.001	.7	.020	.00	.00	.000	.85	13.0	.001
22	0.050	0.001	.4	.020	.00	.00	.000	.55	13.0	.001
23	0.050	0.001	.3	.020	.00	.00	.000	.01	13.0	.001
24	0.050	0.001	.3	.020	.00	.00	.000	.01	13.0	.001
25	0.050	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
26	0.050	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
27	0.050	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
28	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
29	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
30	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
31	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
32	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
33	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
34	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
35	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
36	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
37	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
38	0.050	0.001	.000	.020	.00	.00	2602.57	.001	13.0	.001
39	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001

40	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
41	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
42	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
43	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
44	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
45	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
46	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
47	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
48	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
49	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
50	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
51	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
52	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
53	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
54	0.050	0.001	.000	.020	.00	.00	.000	.05	13.0	.001
55	0.050	0.001	.000	.020	.00	.00	.000	.05	13.0	.001
56	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001

GROUP 9 (AVERAGE RIVER TEMPERATURE)
TEMPER
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0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)

REACH	REFQ	T	HEXN	VEXN	RFDGR
1	50	.045	.516	.353	0.
2	50	.281	.512	.344	0.
3	50	.624	.516	.353	0.
4	50	.448	.550	.346	0.
5	50	.543	.550	.346	0.
6	50	.622	.550	.346	0.
7	50	.297	.540	.266	0.
8	50	.308	.540	.266	0.
9	50	.004	.540	.266	0.
10	50	.284	.540	.266	0.
11	50	.202	.551	.326	0.
12	50	.176	.551	.326	0.
13	50	.154	.551	.326	0.
14	50	.704	.551	.326	0.
15	50	.044	.551	.326	0.
16	50	.147	.551	.326	0.
17	50	.022	.463	.362	0.
18	50	.002	.463	.362	0.
19	50	.021	.463	.362	0.
20	50	.041	.463	.362	0.
21	50	.414	.463	.362	0.
22	50	1.940	.536	.274	0.
23	50	1.799	.523	.288	0.
24	50	1.426	.512	.350	0.
25	50	0.463	.512	.260	0.
26	50	0.805	.512	.260	0.
27	50	1.453	.512	.260	0.
28	50	1.960	.512	.260	0.
29	50	2.350	.512	.260	0.

30	50	2.009	.592	.295	0.
31	50	.038	.592	.295	0.
32	50	.280	.592	.295	0.
33	50	.587	.592	.295	0.
34	50	2.331	.592	.295	0.
35	50	1.524	.598	.335	0.
36	50	1.878	.598	.335	0.
37	50	.348	.598	.335	0.
38	50	.010	.505	.292	0.
39	50	1.077	.627	.358	0.
40	50	1.397	.627	.358	0.
41	50	.011	.632	.294	0.
42	50	1.066	.555	.257	0.
43	50	.827	.687	.252	0.
44	50	.077	.687	.252	0.
45	50	.020	.543	.136	0.
46	50	.994	.543	.136	0.
47	50	.069	.543	.136	0.
48	50	.516	.543	.136	0.
49	50	.127	.543	.136	0.
50	50	.569	.543	.136	0.
51	50	2.151	.543	.136	0.
52	50	2.901	.354	.254	0.
53	50	.180	.555	.351	0.
54	50	.023	.555	.351	0.
55	50	.557	.555	.351	0.
56	50	.471	.536	.289	0.

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)
FNAM
****
ATHA.D11
LSR.D11

ATHABASCA - SCENARIO D12 <== JUNE 13, 1989

NRT	NTRIB	MAXTR	MAXRI	MAXPT	NSTP	NVAR
56	1	4	52	52	33	9

GROUP 2 (ONE LINE FOR EACH REACH)

IRCH	UP1	IUP2	X	Q	QLD	SOURCE NAME
1	0	0	1.7	27.1	0.000	
2	1	0	12.2	26.427	0.673	WELDWOOD <==OPEN
3	2	0	23.6	27.1	0.000	
4	3	0	18.6	27.1	0.000	
5	4	0	22.5	27.1	2.3	LOCAL
6	5	0	25.8	29.4	0.000	
7	6	0	13.3	29.4	5.2	BERLAND R
8	7	0	13.8	34.6	1.3	LOCAL
9	8	0	0.2	35.9	0.000	
10	9	0	12.7	35.9	5.0	LOCAL
11	10	0	9.2	40.9	0.000	
12	11	0	8.0	40.9	0.000	
13	12	0	7.0	40.9	0.000	
14	13	0	32.0	40.9	0.000	
15	14	0	2.0	40.9	0.000	A.N.C <===OPEN
16	15	0	6.7	40.9	0.000	
17	16	0	1.1	40.9	0.000	
18	17	0	0.1	40.9	2.3	McLEOD R
19	18	0	1.5	43.027	0.173	MILLAR WEST.<==OPEN
20	19	0	2.1	43.2	0.1	LOCAL
21	20	0	21.1	43.265	0.035	WHITE STP
22	21	0	70.0	43.3	0.000	
23	22	0	44.6	43.3	0.1	FREEMAN R.
24	23	0	31.5	43.4	0.2	LOCAL
25	24	0	11.5	43.6	0.0000	
26	25	0	20.0	43.6	1.80	PEMBINA
27	26	0	36.1	45.4	0.3	LOCAL
28	27	56	48.7	53.2	0.0000	LESSER SLAVE
29	28	0	58.4	53.2	0.1	LOCAL
30	29	0	53.0	53.288	0.012	STP
31	30	0	1.0	53.3	0.00	ALPAC <===OPEN
32	31	0	7.4	53.3	0.0000	
33	32	0	15.5	53.3	2.5	LA BICHE
34	33	0	61.5	55.8	2.5	CALLING
35	34	0	47.3	58.3	0.0000	
36	35	0	58.3	58.3	2.5	PELICAN
37	36	0	10.8	60.8	0.3	HOUSE
38	37	0	1.0	61.1	0.0000	
39	38	0	33.3	61.1	0.0000	
40	39	0	43.2	61.1	1.45	BUFFALO
41	40	0	1.0	62.55	0.0000	
42	41	0	28.7	62.55	0.0000	
43	42	0	28.9	62.55	0.0000	
44	43	0	2.7	62.55	1.45	HORSE
45	44	0	0.6	63.912	0.088	STP
46	45	0	30.4	64.0	45.2	CLEARWATER
47	46	0	2.1	108.959	0.241	SUNCOR

48	47	0	15.8	109.2	0.8	STEEPBANK
49	48	0	3.9	110.0	0.4	MUSKEG
50	49	0	17.4	110.4	0.6	MCKAY
51	50	0	65.8	111.0	2.5	ELLS
52	51	0	58.9	113.5	7.3	FIREBAG
53	0	0	8.0	7.5	0.	
54	53	0	1.0	7.5	0.	AEC <===OPEN
55	54	0	24.7	7.5	0.	
56	55	0	19.8	7.5	0.	

GROUP 3 (ONE LINE FOR EACH POINT SOURCE INFLOW)

STNAM	INST
WELDWOOD	2
LOCAL	5
BERLAND R	7
LOCAL	8
LOCAL	10
A.N.C.	15
McLEOD R	18
MILLAR WEST.	19
LOCAL	20
STP	21
FREEMAN R	23
LOCAL	24
PEMBINA R	26
LOCAL	27
LESSER SLAVE R	28
LOCAL	29
STP	30
ALPAC	31
LA BICHE R	33
CALLING R	34
PELICAN R	36
HOUSE R	37
BUFFALO R	40
HORSE R	44
STP	45
CLEARWATER R	46
SUNCOR	47
STEEPBANK R	48
MUSKEG R	49
MCKAY R	50
ELLS R	51
FIREBAG	52
A.E.C.	54

GROUP 4 (RIVER NAME FOR PLOT FILE, MAX. 7 CHARACTERS)

RNAM

****

ATHABASCA RIVER

GROUP 5 (ONE LINE FOR EACH TRIBUTARY, OMIT IF NO TRIBUTARIES)

TNAM INTR

****

LESSER SLAVE

GROUP 6 (ONE LINE FOR EACH REACH, IN INCREASING ORDER BY REACH)

REACH	XLD1	XLD2	XLD3	XLD4	XLD5	XLD6	XLD7	XLD8	XLD9
1	0	0	0	0	0	0	0	0	0
2	568.5	7.09	0	0	0.17	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
5	0	11.55	6.4	0	0.23	0	0	0	0
6	0	0	0	0	0.11	0	0	0	0
7	0	9.53	6.4	0	0.17	0	0	0	0
8	0	11.55	6.4	0	0.17	0	0	0	0
9	0	0	0	0	0.09	0	0	0	0
10	0	11.55	6.4	0	0.14	0	0	0	0
11	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0.26	0	0	0	0
13	0	0	0	0	0.14	0	0	0	0
14	0	0	0	0	0.33	0	0	0	0
15	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0.23	0	0	0	0
18	0	5.76	5.12	0	0.34	0	0	0	0
19	1364.8	7.39	0	0	0.16	0	0	0	0
20	0	11.55	6.4	0	0	0	0	0	0
21	10.6	4.4	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0
23	0	9.6	7.68	0	0.26	0	0	0	0
24	0	11.55	6.4	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0
26	0	1.46	8.96	0	0.02	0	0	0	0
27	0	11.55	6.4	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0
29	0	11.55	6.4	0	0.23	0	0	0	0
30	30.6	5.0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0
33	0	3.24	13.44	0	0.25	0	0	0	0
34	0	11.45	3.84	0	.54	0	0	0	0
35	0	0	0	0	0	0	0	0	0
36	0	13.01	10.24	0	0.10	0	0	0	0
37	0	9.08	3.84	0	0.05	0	0	0	0
38	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0
40	0	13.15	4.48	0	0.05	0	0	0	0
41	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0
44	0	12.95	2.56	0	0.05	0	0	0	0
45	142.30	5.0	0	0	0	0	0	0	0
46	0	12.52	2.24	0	0.04	0	0	0	0
47	3.8	5.0	0	0	0	0	0	0	0
48	0	13.09	5.12	0	0.16	0	0	0	0
49	0	5.95	3.84	0	0.11	0	0	0	0
50	0	11.95	5.12	0	0.22	0	0	0	0

51	0	12.41	3.84	0	0.08	0	0	0	0
52	0	5.25	5.12	0	0.37	0	0	0	0
53	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0

GROUP 7 (ONE LINE FOR EACH HEADWATER)

X01	X02	X03	X04	X05	X06	X07	X08	X09
0.0	11.14	6.4	0	.05	2.94	0	0	0
0.0	12.94	2.56	0	.31	0.000	0	0	0

GROUP 8 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH)

REACH	XK1	XK2	XK3	XK4	XM1	XM2	XM3	XRES	XDS	XP
1	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
2	0.035	0.58	.15	.020	.00	.00	.000	2.33	13.0	.001
3	0.035	0.001	.1	.020	.00	.00	.000	1.97	13.0	.001
4	0.035	0.001	.1	.020	.00	.00	.000	1.26	13.0	.001
5	0.035	0.001	.05	.020	.00	.00	.000	.36	13.0	.001
6	0.035	0.001	.05	.020	.00	.00	.000	.25	13.0	.001
7	0.035	0.001	.05	.020	.00	.00	.000	.25	13.0	.001
8	0.035	0.001	.05	.020	.00	.00	.000	.25	13.0	.001
9	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
10	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
11	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
12	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
13	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
14	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
15	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
16	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
17	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
18	0.035	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
19	0.050	1.63	.7	.020	.00	.00	.000	.001	13.0	.001
20	0.050	0.001	.7	.020	.00	.00	.000	.72	13.0	.001
21	0.050	0.001	.7	.020	.00	.00	.000	.72	13.0	.001
22	0.050	0.001	.4	.020	.00	.00	.000	.72	13.0	.001
23	0.050	0.001	.3	.020	.00	.00	.000	.47	13.0	.001
24	0.050	0.001	.3	.020	.00	.00	.000	.09	13.0	.001
25	0.050	0.001	.0	.020	.00	.00	.000	.09	13.0	.001
26	0.050	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
27	0.050	0.001	.0	.020	.00	.00	.000	.001	13.0	.001
28	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
29	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
30	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
31	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
32	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
33	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
34	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
35	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
36	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
37	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
38	0.050	0.001	.000	.020	.00	.00	2602.57	.001	13.0	.001
39	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001

40	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
41	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
42	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
43	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
44	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
45	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
46	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
47	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
48	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
49	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
50	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
51	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
52	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001
53	0.050	0.001	.000	.020	.00	.00	.000	.001	13.0	.001
54	0.050	0.001	.000	.020	.00	.00	.000	.05	13.0	.001
55	0.050	0.001	.000	.020	.00	.00	.000	.05	13.0	.001
56	0.050	0.001	.000	.020	.00	.00	.000	.15	13.0	.001

GROUP 9 (AVERAGE RIVER TEMPERATURE)

TEMPER

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0.0

GROUP 10 (ONE LINE FOR EACH REACH IN INCREASING ORDER OF REACH NUMBER)

REACH	REFQ	T	HEXN	VEXN	RFDGR
1	50	.045	.516	.353	0.
2	50	.281	.512	.344	0.
3	50	.624	.516	.353	0.
4	50	.448	.550	.346	0.
5	50	.543	.550	.346	0.
6	50	.622	.550	.346	0.
7	50	.297	.540	.266	0.
8	50	.308	.540	.266	0.
9	50	.004	.540	.266	0.
10	50	.284	.540	.266	0.
11	50	.202	.551	.326	0.
12	50	.176	.551	.326	0.
13	50	.154	.551	.326	0.
14	50	.704	.551	.326	0.
15	50	.044	.551	.326	0.
16	50	.147	.551	.326	0.
17	50	.022	.463	.362	0.
18	50	.002	.463	.362	0.
19	50	.021	.463	.362	0.
20	50	.041	.463	.362	0.
21	50	.414	.463	.362	0.
22	50	1.940	.536	.274	0.
23	50	1.799	.523	.288	0.
24	50	1.426	.512	.350	0.
25	50	0.463	.512	.260	0.
26	50	0.805	.512	.260	0.
27	50	1.453	.512	.260	0.
28	50	1.960	.512	.260	0.
29	50	2.350	.512	.260	0.

30	50	2.009	.592	.295	0.
31	50	.038	.592	.295	0.
32	50	.280	.592	.295	0.
33	50	.587	.592	.295	0.
34	50	2.331	.592	.295	0.
35	50	1.524	.598	.335	0.
36	50	1.878	.598	.335	0.
37	50	.348	.598	.335	0.
38	50	.010	.505	.292	0.
39	50	1.077	.627	.358	0.
40	50	1.397	.627	.358	0.
41	50	.011	.632	.294	0.
42	50	1.066	.555	.257	0.
43	50	.827	.687	.252	0.
44	50	.077	.687	.252	0.
45	50	.020	.543	.136	0.
46	50	.994	.543	.136	0.
47	50	.069	.543	.136	0.
48	50	.516	.543	.136	0.
49	50	.127	.543	.136	0.
50	50	.569	.543	.136	0.
51	50	2.151	.543	.136	0.
52	50	2.901	.354	.254	0.
53	50	.180	.555	.351	0.
54	50	.023	.555	.351	0.
55	50	.557	.555	.351	0.
56	50	.471	.536	.289	0.

GROUP 11 (ONE LINE FOR EACH RIVER OR TRIBUTARY)
FNAM
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ATHA.D12
LSR.D12